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LETTER OF TRANSMITTAL

To His Excellency L. S. Ross, Governor of Texas:

SIR— I have the honor to transmit to you the Third Annual Report of the Texas Agricultural Experiment Station, with attached Bulletins Nos. 9-13 inclusive, issued during the year 1890.

Very respectfully,

A. J. ROSE,

President of the Board of Directors, A. and M. College of Texas.

TEXAS AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 9,

MAY, 1890.

PEAR STOCKS.

SOME PARASITIC FUNGI OF TEXAS

WITH NOTES.

AGRICULTURAL AND MECHANICAL COLLEGE,

College Station, Brazos County, Texas.

BY ORDER OF THE COUNCIL: F. A. GULLEY, DIRECTOR.



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C. K. FUQUA	Sugar Chemist.

PEAR STOCKS.

BY THOS. L. BRUNK.

MAY, 1890.

The best stock on which to graft or bud the pear has been a theme of much discussion and a line of considerable experimentation. Downing* wrote long ago: "Experience has proved that in proportion to the likeness or close relation between the stock and the graft is the long life of the grafted tree. Thus a variety of pear grafted on a healthy pear seedling lasts almost as long as upon its own roots. Upon a thorn it does not endure so long; upon a mountain ash or quince stock still less, until the average life of a pear tree when grafted on the quince is reduced to one-third of its ordinary duration on the pear stock. It arises from the want of affinity between the quince stock and the pear graft. The practice, therefore, of grafting pear on quince and the peach on the plum, when extensive growth and durability are wanted, is wrong." Again he says: "A variety of fruit which is found rather tender for a certain climate or a particular neighborhood, is frequently acclimatized by grafting it on a native stock of very hardy habits." Furthermore, "The apparent decay of a variety is often caused by grafting upon unhealthy stocks."

Field states† that the cause of the failure of pears is due to the practice of gathering seeds for stocks from any and every source; from diseased fruits and from the fruit of diseased trees; while the seed of small and wild pears only are fit for the purpose.

Barry states‡ "It scarcely admits of a doubt but that many of the difficulties met with in fruit tree culture, as maladies of various sorts, unfruitfulness, etc., are induced by a careless and indiscriminating system of propagation. The stock has a most important influence on the health, longevity, fruitfulness, and symmetry of the tree, and should therefore be propagated and selected with due regard to its soundness, vigor, and hardiness of constitution."

From these quotations from so high authorities the reader can gather, (1) that there must be a close affinity between stock and scion for long life and health of a tree; (2) that stocks through high culture and bad selection of seeds become deteriorated and unfit for use; (3) that stocks should be adapted to the climate and soil in which the trees are grown; (4) that many of our best varieties of pears have been so reduced in constitutional vigor by working them through a series of generations on weak and poor stocks that they have become almost worthless as a tree and subject to the inroads of disease; (5) that the present weakened and short lived pear tree is the result of man's neglect and misuse of nature's laws and powers.

This discussion has of late been so warm, and opinions so diametrically opposed, and the question of the proper stock for the pear (especially for the LeConte and Keiffer) of such vast importance to our Southern nurserymen and fruit growers that it was deemed a case pre-eminently fitted for careful obser-

* Downing's Fruit and Fruit Trees of America, pp. 11 and 29.

† Field's Pear Culture, p. 90.

‡ Barry's Fruit Garden, p. 80

vation and experimentation. Last fall the work was begun by making a number of visits to orchards in several parts of the State, and by sending out letters of inquiry to all parts of the State and throughout the South. During the past winter all the stocks on which pears are "worked" as standards were procured and placed in the experimental grounds, and on them were worked the LeConte and Keiffer and several other pears. The stocks include the LeConte and Keiffer grown from cuttings from "pedigree" trees, French seedling pears, Mikado pear seedlings, and apple seedlings. The grafts were made so as to force the scion in every case to grow on the roots of the stock only. These grafts are all growing nicely, and we will be able to throw more light on this subject, or prove the conclusions drawn in this bulletin, which is only a report of our observations and the testimonials we have received from experienced growers. While I may answer other questions more or less, yet the one of first importance to decide is which is the best stock for the LeConte and Keiffer pear trees, the Oriental (i. e. the LeConte or Keiffer on their own roots) or the French pear seedling. Before going into the details of our observations, I will state briefly the claims of the advocates of both these stocks.

The claims of the friends of the French pear seedling or well grown American pear seedlings from European pear seed as a stock for the Le Conte and Keiffer pear trees are as follows:

1. The trees make fully as good growths as those grown on their own roots.
2. They come into bearing one or two years sooner.
3. They are fully as prolific or more so.
4. They do not sucker or sprout from the roots any more than other fruits on seedling stocks of the same species.
5. Are less subject to blight.
6. The affinity between Oriental pears and the French stock is close, but the Oriental pear being a more vigorous grower than the American or European pears, they influence the stock to the extent of forming enlargements, which do no harm.

The friends of the "pedigree" Le Conte and Keiffer stock for these two pears claim:

1. That these pears on their own roots make a far better and more uniform growth than those on French stock.
2. That while they do not always come into bearing quite as soon as a rule as those on the French stock, yet when they do begin to bear they produce more per tree, and continue to increase year after year, while those on French stock die early and do not bear uniformly, some bearing profitable crops and others none.
3. That those on their own roots never sucker from the roots, while the sprouts from the roots of the French stock are so numerous and persistent that they become a great nuisance to the cultivator, necessitating high pruning to get at them.
4. That those on French stock are more subject to disease than those on their own roots.
5. That the affinity of the French stock for the Oriental pear is not close, as the stock becomes much enlarged below the place of graft, and also throws out excrescences of abnormal tissue near the top of the stock.

After visiting a number of orchards in North, Central, and Southern Texas and examining the roots (often over three feet below the surface) of grafted and ungrafted trees, removing some entirely from the soil and splitting open the trunk and finding the original graft, noting the comparative growth between trees of the same age and under the same treatment, and making a few sketches of specimens showing the exact conditions of stock and scion after

several years' growth, I am able to give what I believe to be a pretty full exposition of the facts involved in this question.

The first important fact to be noted from my observations is that where the Le Conte or Keiffer were grafted upon the French stock or apple stock, and were set deep enough, the scion invariably threw out its own roots; and from the various stages of growth examined I found that the scion made an effort proportionate to its strength and hold upon the soil to throw off the stock, and in several cases had succeeded in doing it, as is shown in Figures 2, 4, and 7, pages 12, 13, and 14. It had almost thrown off the apple stock, as shown in Figure 3, page 12.

This tendency to make its own roots and discard the French stock and grow thriftily when the point of graft is set below the surface of the soil has led some to the erroneous belief that the Le Conte grows as well on the French stock as on its own roots. The proportion of French roots to the Le Conte roots could in every case be told by the growth of the tree, for in every case where the French roots were present the growth of the tree was less than those on their own roots only.

It is no sign or proof that a tree is growing on a particular stock simply because it was grafted upon it. We have two Clapp's Favorite trees here some fourteen years old and both grafted on the quince stock. One of them has about two-thirds of its own roots, and the other has nearly all quince roots. The first one is far larger than the one depending on the quince stock for a food supply. It seems clear to me that it is far better, and in fact the only right way when vigor and growth are considered, either to grow the Le Conte and Keiffer from cuttings, or side graft a piece of a root of a pear or apple seedling to support the cutting till it sends out its own roots, and in the fall when removed from the nursery, cut off the grafted root.

It is a grave mistake to believe, as Wickson states,* that roots from a cutting spread out horizontally and irregularly in all cases and do not give the tree a deep, strong hold on the soil. This is especially so with the Le Conte pear. I have seen roots from Le Conte cuttings at the end of the first season that had penetrated the hardest joint clay to a depth of over four feet and at nearly a vertical angle. By comparing Figures 3, 5, and 7, pages 12, 13, 14, with Figure 4, page 12, it will be seen that the Le Conte penetrates the soil at a more vertical angle than the Keiffer.

The second feature of growth observed was that where the Le Conte and Keiffer and other varieties were planted so shallow that they were forced to grow upon the French or apple stock, that the stock outgrew the scion in every case, forming an ugly enlargement (Figs. 1 and 6, pp. 11 and 14) from the point of graft downwards, and in all cases they threw up sprouts (see Figs. 1 and 6). These sprouts make it difficult to cultivate an orchard, as an incessant amount of labor is necessary to keep them down, and it requires high pruning of the limbs that they may be reached.

Another peculiar growth, that proves more than any other the lack of affinity between the Le Conte scion and French stock, are excrescences thrown out on the top of the stock. These are bunches of abnormal growths of both bark and wood, often nearly as large as a hen's egg. Such growths never occur where the circulation of the sap is not impeded in some way. They are not the work of insects, as there are no signs of their presence. They were observed only on the Le Conte and Keiffer grown on French stock. I was told that not long after these growths appeared the roots died and the trees above remained green to the last.

*California Fruits, p. 101.

These enlargements and excrescences are certainly signs of non-affinity.

Lindley,* one of our highest authorities, says: "Whenever the stock and graft or bud are not perfectly well suited to each other, an enlargement is well known always to take place at the point of their junction, and generally to some extent either above or below it." It will be noticed, in reading the opinions of the correspondents appended, that they are nearly unanimous in believing these enlargements to be signs of non-affinity.

In the third place, it was observed that grafted trees *forced to grow only on the French stock* were far less vigorous and less uniform in their growth than those on their own roots. Some of the grafted trees are more than double the size of other grafted ones, while those on their own roots are symmetrical and uniform to a high degree. As to time of coming into bearing and prolificness of grafted and ungrafted Le Conte and Keiffer trees, there is no doubt that the grafted tree bears younger in most localities, but it never bears as heavily as the tree on its own roots. The time when the Le Conte on its own roots begins to bear varies with the conditions of soil, latitude and culture. I found Le Conte trees in North Texas on their own roots struggling for an existence on ground which consisted of about twenty inches of a sandy loam over a reddish yellow clay, with considerable sand intermixed. This subsoil was wet and soggy, although it had not rained for over four weeks. The roots of the Le Conte trees in this soil did not spread out in the sandy soil (see Fig. 5) as did several Keiffers near by, but plunged down into the wet clay, the first root being fourteen inches from the surface. Only two of the six Le Conte trees that had been set ten years before remained. They had never borne but few pears. They had all been attacked by pear blight, and those that remained were badly affected. But the roots at a depth of three feet had a black epidermis, and in many places were covered with a fungous growth, apparently saprophytic. No doubt all of these trees were affected at the roots first. Near by these LeContes were some eight-year old Keiffers that had been grafted on the French stock. But after a careful examination of the roots and collar, no sign of the French stock could be found. The trees had formed their own roots, killed and thrown off the French stock, spread their roots out into the soil (as shown by Fig. 4), had borne heavy crops for several seasons, and had not blighted. It seems evident that the whole difference in growth between these LeContes and Keiffers, apparently under the same conditions, was due to the fact that they fed entirely in two different fields, as it were, although one was on top of the other. The one lived in the rich loose soil, the other in the wet subsoil. The same subsoil, if well drained, will no doubt raise good Le Conte trees. The owner of these trees, Dr. W. W. Stell, in his letter on page 17, states that 25 per cent of his young grafted Le Conte trees are affected with what he believes to be root-rot. These trees were all set deep and have formed their own roots, which, like all Le Conte roots, have gone down into the subsoil. On his place it seems to hold too much water too near the surface, and the trees die. The soil is deep, and the apple trees, etc., he speaks of surrounding the orchard spread their roots out like the Keiffers, above, and therefore thrive.

On the other Le Conte trees on their own roots, in Central Texas, at Navasota, about two hundred miles south of these mentioned above, on a similar top soil, but not so deep, and having a heavy joint clay subsoil with a better natural drainage, on the 2d day of April, 1889, I counted as high as 243 young pears nicely set upon a single tree. These trees were just entering their third summer's growth and had borne a few pears the summer before. In other parts of the State, as down on the coast prairie and on the black waxy lands,

*Lindley's Horticulture, p. 226.

they do not begin to bear till five and six years old. Evidently there are localities far better adapted to the highest development of the Le Conte than others. These places largely remain yet to be found. When found they should be carefully placed upon a map for proper reference. In Germany they have made such an exhaustive study of the adaptability of certain varieties of fruits for the several parts of that country that nearly every square mile has its own special varieties that it can mature and develop to a higher degree of perfection than can be done on the adjacent lands. Every State in the South, and especially Texas, could well afford to have at least one man in the field to collate and map out the facts regarding the adaptability of certain fruits for certain localities. We annually plant thousands of trees on various soils and under varying conditions, and expect profitable results in every case. Every section of a State has certain kinds and varieties of kinds of fruits it can grow more or less to perfection, and those should be more carefully sought out and grown, to the exclusion of all worthless and unacclimated fruits.

Mr. William Jennings, of Thomasville, Georgia, claims that it is unpruned and uncultivated trees that bear at three and four years of age, and when properly pruned and cultivated they will not bear till seven years old, but these at nine and ten will bear from five to fifteen bushels to the tree.

I believe my observations as to pruning bear him out in his statements, as the young trees at Navasota on which so many pears were counted had not been pruned at all, as the owner did not believe in pruning the Le Conte. They were, however, well fertilized with cotton seed meal and barn manure, and were well cultivated.

Reports from Missouri, North Georgia, and Tennessee show that the Le Conte blooms too early to be prolific, and is subject to severe attacks of pear blight. The Keiffer in these States has proven far more hardy and prolific. William Jennings also states in his pamphlet on the Le Conte pear: "We have seen them thriving on all kinds of soil that we have in Georgia, except wet land." T. V. Munson, in *American Garden*, states: "Light deep sandy pine ridges will grow Le Conte and Keiffer pears."

So far as I have observed and inquired, I am confident that the Le Conte thrives best in every respect in a strip of territory not over a hundred miles wide, and lying next to the Gulf from Texas to Florida inclusive. Also that it must be grown on well-drained lands, and best on a heavy clay subsoil with a shallow soil above.

As to the Le Conte or Keiffer being more subject to diseases on a particular stock, I will say that it depends on soil, latitude, and culture. As already shown, the Le Conte and Keiffer are far less subject to blight on well drained soils in the Gulf region on their own roots than on the French stock.

Professor J. P. Campbell, of Georgia, in a most carefully prepared paper* on the subject of pear blight, says: "The first precaution which should be observed is to plant only those trees which are proven by experience not to blight readily, and so far as I can learn the Le Conte and Keiffer seem to be most nearly exempt."†

In higher latitudes they seemed to blight on their own roots about as freely as other pears. But in the Gulf region there is a disease which affects the roots of cotton, sweet potatoes, apples, figs, and several other plants on certain spots of ground. This disease has been termed "root-rot" by Prof. Pammel.‡ The pear tree dies on the same spots of ground, and I believe from the same fun-

*Proceedings Fourteenth Annual Meeting Georgia State Horticultural Society, page 24.

†See numerous other testimonials appended.

‡Texas State Agricultural Experiment Station Bulletin No. 4, p. 11.

gus agent as that which causes cotton root-rot (*Ozonium arnicomum*, Lk). In his investigations of the cotton root-rot Prof. Pammel has this to say about the disease affecting the pear:* "The pear is said also to be affected. Specimens sent to me from Burnet County had plenty of *Ozonium*, but the trees had evidently been dead for some time. In the pear orchard of Mr. R. D. Blackshear [Navasota] the leaves of trees covering an area of several acres became yellow and soon died. The pear trees alongside of this patch were perfect, showing no signs whatever of yellow leaves. The roots of the trees with yellow leaves were examined carefully, but no fungus was found on the roots except in advanced stages, where numerous threads of the *Ozonium* were present; but I think in those cases the fungus was simply a saprophyte. * * * I am unable to account for this disease. The leaves of the young apple trees affected with root-rot suddenly wilt, become black, and in a short time perish."

The description above of how this disease affects the apple tree agrees more nearly with my observations of what I believe to be the same disease of the pear. A tree will start out seemingly perfectly healthy in the spring and make a vigorous growth, but bears no fruit; and at any time during the summer or fall the leaves will suddenly wilt and turn black, and drop off within a few days, and black spots appear all over the tree, which gradually enlarge till the whole tree turns black and dies. All these visible stages develop within a month. Some of these dead trees stood on a reddish-yellow clay subsoil, some on a slate-colored clay subsoil, and others on a gray clay full of particles of the limestone rock, a stratum of which is but a few feet beneath. On digging up the roots, in every case they were found to be rotted and generally clothed with a white fungus growth. It is not my purpose, however, to prove or disprove that the Le Conte pear dies by an organic disease on spots of ground where cotton and other plants die. But whether organic or some poisonous chemical in the soil, the Le Conte and Keiffer on their own roots or other stocks are sure to perish when planted on those spots of ground. I can say that I never saw a pear tree die with this disease planted on a heavy red or joint clay subsoil. The Le Conte and Keiffer grafted on the French stock will not live more than about seven years if forced to grow only on that stock. The stock seems to be inadequate to the demands of the vigorous scion, and in a few years the tree becomes stunted in growth, throws up numerous sprouts from the roots, sends out the soft, spongy excrescences described above, and finally the roots die while the top remains green† to the last. On the same grounds on which the grafted Le Conte and Keiffers were found dying on the French roots, they were growing on their own roots and planted on a stiff joint clay subsoil which in the lower end of the orchard cropped out. A finer, more uniform, luxuriant, and healthy lot of trees I have never seen anywhere else.

In all of my correspondence only three recommend the use of the French stock for the Le Conte and Keiffer pears, while many, without solicitation on my part, stated that they believed the Le Conte to be the best stock for European pears.

I can not leave this question without referring to some commendable work undertaken by Mr. William Jennings, of Thomasville, Georgia, in connection with the Le Conte stock for other pears. In his pamphlet, "Pears and Pear Trees for the South," he states: "A few years ago we selected over thirty varieties (European pears), such as were likely to be valuable in the Southern States, with a view of trying to reinvigorate them by working them repeatedly on Le Conte stocks. Our plan has been to work the same variety several

* Texas State Agricultural Experiment Station Bulletin No. 7, p. 12.

† See also letter of Mr. H. M. Stringfellow, p. —.

times, each time taking grafts from the last tree worked and a fresh Le Conte. We have followed this up from year to year with a number of the European varieties. There is no longer any doubt but that an improvement has been made and that we will ultimately have strains of comparatively healthy trees. In other words, the final result is likely to be that we will have strains of trees of the European kinds as able to resist blight as the Asiatic varieties."

This is a line of work we had begun at this Experiment Station before we learned of this advanced investigation. We, however, shall go on with the work, that we may be able before many years to substantiate or explode the validity of Mr. Jennings' experiments. As to the use of the apple seedling for a pear stock, my observations confirm the idea that they are even worse than the French pear seedling to sucker, and the trees are short lived. The Le Conte scion rejects them the same as it does the French seedling, as is shown in Figure 3. But as apple seedlings are plentiful and cheap, it may be a good plan, on soils where the Le Conte and Keiffer do not root easily, or a profitable percentage of the cuttings do not grow, to use them or pieces of them to side-graft on Le Conte cuttings as a nurse to aid in keeping the cutting alive till it forms its own roots. In the fall, when the trees are removed from the nursery, the apple root can be removed and the tree left on its own roots.

FIGURES AND EXPLANATIONS.

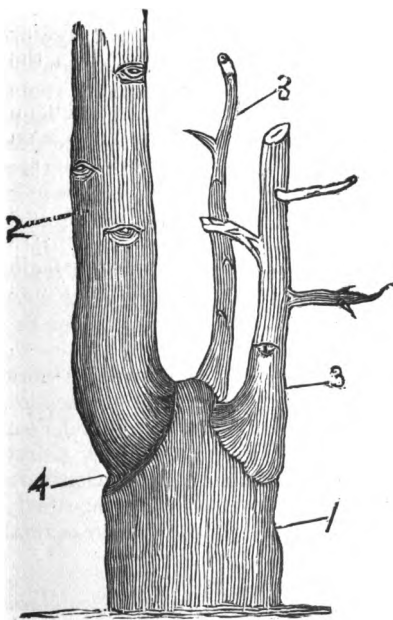


FIG. 1.

1. French Pear seedling stock.
2. Le Conte scion 3 years old from bud, and $3\frac{1}{2}$ inches in diameter.
- 3, 3. Sprouts from the French stock.
4. Place where bud of Le Conte was inserted.

This sketch was taken from a tree at Sherman, Texas, on Mr. J. S. Kerr's fruit farm. It can readily be seen that the French stock is about double the diameter of the Le Conte scion. There was no possibility of the scion in this case to make its own roots. There were several more sprouts than are shown in the cut. Original.

FIG. 2. A LE CONTE ORIGINALLY GRAFTED ON A PIECE OF AN APPLE ROOT.

The apple root was 4 inches long and the Le Conte scion about 8 inches long. The scion was set 6 inches deep into the soil, and hence formed its own roots, as no trace of the apple root could be found, as shown at 1.

2. Surface of ground.

Tree four years old and $7\frac{1}{4}$ inches in diameter. It was never removed from the nursery row. Taken on Mr. J. S. Kerr's place, at Sherman, Texas. Original.

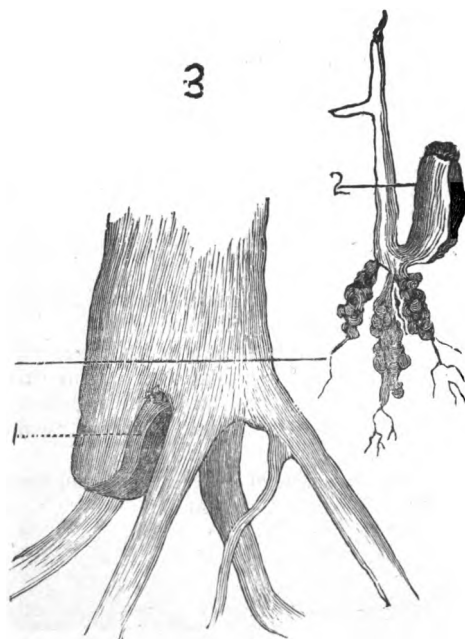
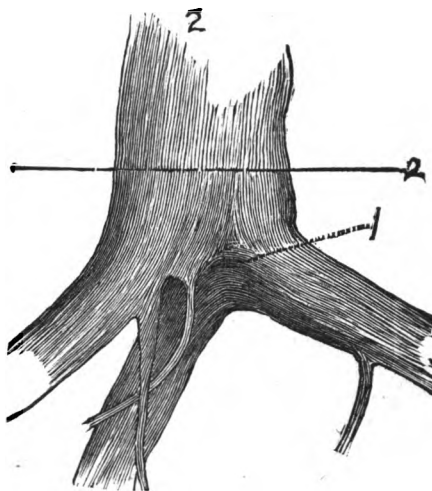


FIG. 3. LE CONTE ON APPLE.

1. Socket in Le Conte tree or scion from which was taken the remains of the apple stock.

2. Remains of apple stock on which this Le Conte had been grafted four years before. The apple stock was totally on the outside of the tree and had a few knotty roots and a few sprouts, as shown in the figure. All the main roots were from the Le Conte scion.

Taken on Mr. J. S. Kerr's place, at Sherman, Texas. Original.

FIG. 4. KIEFFER ON FRENCH STOCK.

1. Surface of ground.
2. Extent of the sandy soil, which was 20 inches deep.

This figure was made from a tree eight years old that had been grafted on the French stock, but had thrown it off completely. All the roots shown in the cut are from the Keiffer scion. It will be noticed also that the roots spread out in the sandy soil above the reddish-yellow wet clay beneath 2. Also that this tree was planted so deep that the Keiffer scion was several inches in the soil. This tree bore several heavy crops. Taken at Dr. W. W. Stell's place, near Paris, Texas. Original.

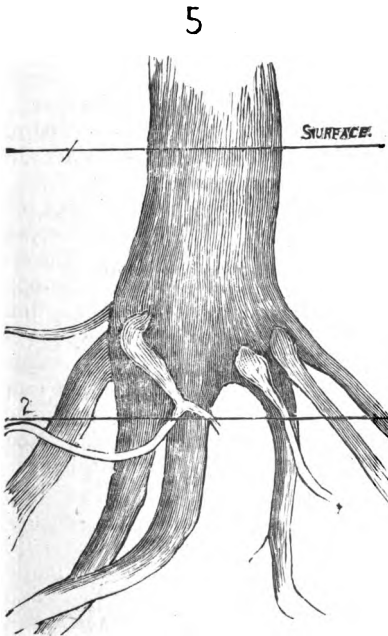
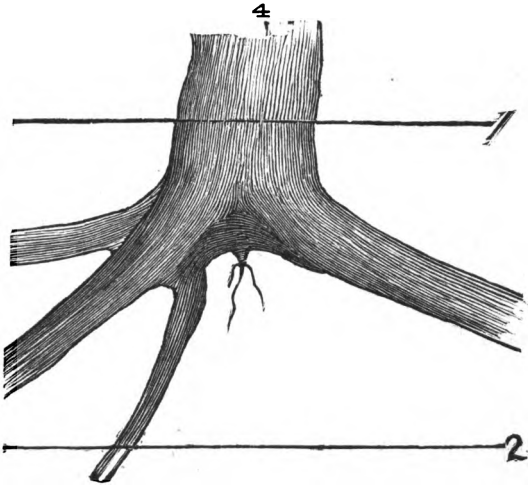


FIG. 5. LE CONTE ON ITS OWN ROOTS, IN A DISEASED CONDITION.

1. Surface of soil, which is a sandy loam.
2. Surface of wet reddish clay subsoil, twenty inches below surface.

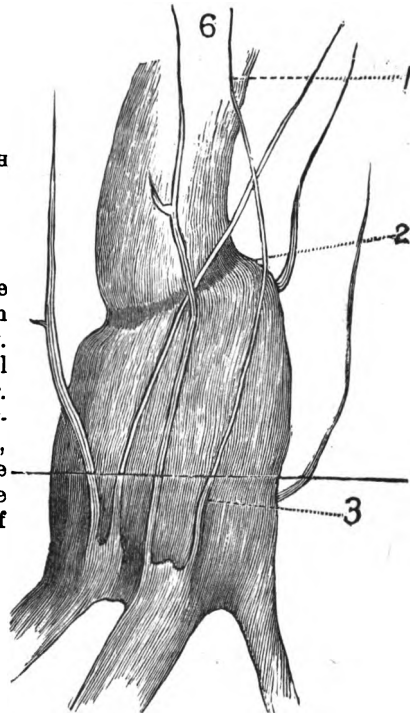
It will be noticed that the roots of this tree plunged down deep into the clay subsoil. The tree is ten years old, and never bore but a few pears. Referred to on page 8.

Taken at Dr. W. W. Stell's place, near Paris, Texas. Original.

FIG. 6. BARTLETT PEAR ON THE FRENCH STOCK.

1. Bartlett scion.
2. Place where bud was set.
3. Sprouts from the French stock.

The line indicates the surface of the ground. The scion is much smaller than the stock, showing a lack of affinity. Tree four years old; on black waxy soil at McKinney, Texas, on the farm of Mr. E. W. Kirkpatrick. On this place several Bartletts died on the French stock, while others on Le Conte stock were fine specimens of luxuriant growth, and were without the "maul" or enlargement of the stock.



7

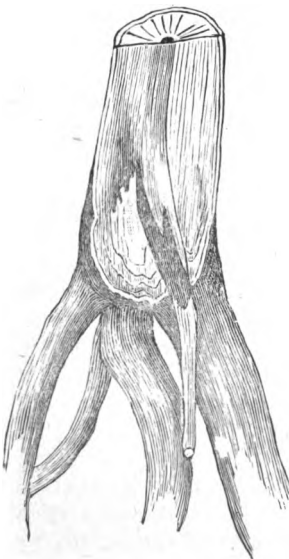


FIG. 7.—This figure shows a vertical section through the base of a three-year-old Keiffer tree that was grafted on the French stock, showing the original graft, the stock of which was entirely dead and decayed, but not grown over by Keiffer wood so as to be hidden. The original cut surfaces of the graft were plainly visible, as shown in the cut. This tree was set deep enough for the scion to throw out its own roots, which soon overpowered those of the stock, and finally killed them. Two Keiffers at this same place were found growing entirely on the French stock, and they were about half the size of those that had been able to throw out their own roots and kill the French stock. Those also on the French stock were tall and slim in their habit of growth, and leaves of a lighter shade of green than of those on their own roots, which had a more stocky and shorter branched habit of growth. Taken on the farm of E. W. Kirkpatrick, McKinney, Texas. Original.

NOTE.—These figures illustrate the same characters found on pear trees in other parts of the State. I am especially indebted to Messrs. J. S. Kerr, E. W. Kirkpatrick, and Dr. W.

W. Stoll for the liberal use of their orchards for making observations, and the sacrifice of several more or less valuable trees. Also to Mr. H. M. Stringfellow, of Hitchcock, Texas, for the use of his orchard and numerous specimens of diseased and other trees, and to R. D. Blackshear, of Navasota, Texas, for the use of his large orchard and the liberal sacrifice of several trees. We are under obligations also to those who have furnished us valuable information in answer to the several queries we sent out.

ANSWERS TO INQUIRIES

SENT OUT FROM THE HORTICULTURAL DEPARTMENT.

In order to get the observations and opinions of prominent pear growers all over the South, the following set of questions was sent out:

"1. Have you observed any difference in the growth or productiveness of Le Contes and Keiffers on the French and Le Conte stock? Please examine the roots of the thriftiest tree grafted on French stock, and note if the tree is not growing almost wholly on its own roots; examine one of the least thrifty, and note if it is not fed largely from the French stock.

"2. Have you noticed that pear trees sprout from the roots when growing on French roots, making it difficult to cultivate the ground?

"3. Have you noticed any blighting or dying of Le Contes or Keiffers on their own roots, on spots where cotton dies, or any other places? Please examine roots of a dying tree, if at hand, and note if disease began at the roots first. Please send me small pieces of dead parts of roots, and section of wood with diseased bark.

"4. Have you had any experience with pears on apple roots; if so, what is your opinion of their value?

"5. Have you noticed enlargements at the point of graft on the French stock, making the stock larger than the body of the tree above? Would you consider such enlargement of the root stock an indication of perfect affinity of the stock and scion?

"6. Have you noticed that grafted trees or those on French stock were more diseased, or subject to the same, than those on Le Conte or Keiffer roots?

"7. What is your soil and subsoil?

"Any other information on Le Conte or Keiffer pears, and pear blight, or root-rot, would be of value to me."

To these queries I received some very valuable and convincing information. Deeming it of special interest to the nurseryman and fruit grower, I herewith append extracts from each letter.

GEORGIA.

J. N. McKinnon, Thomasville, Georgia: When we bought the land where we live there were 200 Le Conte trees on it. Twelve of them had been grafted on French or some other stock. These put up sprouts every spring, and we find them very troublesome. The trees are only about half the size of those on their own roots.

We have had considerable blight in our county on the Le Conte on the same patches of land that rust collects. The blight commences in the limbs and runs down. Will mail you a piece to-morrow. [Limb was received and it was genuine blight]. I have had no experience with apple roots. Our soil generally sandy. Subsoil yellow clay, mixed with sand.

William Jennings, Thomasville, Georgia: You ask for dead Le Conte pear tree roots from Thomasville or vicinity. I doubt if any can be found. I have been told that a few grafted Le Contes near Boston, in this county, died apparently of the blight that has prevailed here for the past two years, but none either "pedigree" or grafted have died within eight or ten miles of Thomasville, that I know of. There are many thousand Le Conte trees within a few miles of my residence, and none of them have been seriously injured by the blight. The body and roots are never affected. The trouble begins in the tender twigs and ends there.

You ask for evidence as to the value of the Le Conte as a stock for other pears. I can only say that I have been growing pear trees in Georgia for thirty years, and never had any success with the European varieties until I began several years ago to graft or bud them on the Le Conte stocks or other stocks of the Asiatic race. After the first year or two those on Le Conte stocks grew far ahead of those on French stocks, and the result is a much thriftier and larger tree. I have them growing near each other under the same conditions, and the appearance is marked in favor of those on Le Conte. I also find the "wildings" or thorny seedling pears of Japan most excellent as stocks for the European race of pears.

P. J. Berkman, Augusta, Georgia, January 6, 1890: In reply to your queries of December 26, I beg to answer as follows: In the controversy which lately appeared in the Southern Horticultural Journal between Messrs. Stell and Stringfellow, in which I am quoted at length by my friend Stell, I fully endorse him on every point which he holds.

1. I have grown the Le Conte pear on imported seedling stocks perhaps in larger quantities than any nursery in the United States, and for a longer period, and for our section and stiff red soil we decidedly give preference to trees grown upon such stocks.

2. Our trees do not sprout from the stocks.

3. We have noticed for several years past, and in several localities in Georgia, many cases of disease on Le Conte and Keiffer grown upon their own roots, the past season, however, being free from the appearance of this scourge in this section. Not having any dying trees on hand, I can not comply with your request to send you pieces of same.

4. We have had much experience with trees grafted upon apple root, this dating back for more than forty-five years, and find such stock utterly useless for trees; while they grow for a year or two quite thriftily, they soon accomplish their career of growth.

5. Your question as to the enlargement of the stock on the point of graft making the stock larger than the body of the tree, depends entirely upon the variety which is grafted upon such stock, as it is a well known physiological fact that the graft influences the stock at a much greater ratio than the stock influences the graft. Hence by grafting Le Conte, Keiffer, and other of the Oriental pears upon seedling pear stocks, the latter increases in diameter at a much greater rate than it would when grafted with Bartlett or other slow growing sorts.

6. Question to No. 1 will answer this: We have a variety of soils, from gray lands to very stiff clay, gravelly loam, and rich bottom lands. The up-

lands mainly underlaid with red clay and the bottom land with a lighter colored subsoil.

G. W. Stoner, Jewella, Louisiana, January 10, 1890: In answering the questions you ask, will first state that last winter and the previous winter I had all except five of my Le Conte trees top-grafted with Howell, Lawson, and Madeline. The Lawson grafts all did well, and a few Madeline, but only about one in twenty-five of the Howell are doing any good. Now to your questions: My Le Contes all grew off fairly well; those on their own roots making, I think, slightly the most growth; but noticed no difference in their coming into bearing. So far as I have examined, all have put out roots from the Le Conte scion. I have noticed that some pear trees sprout from the roots very badly on French stocks, and have also several Le Conte trees on their own roots that have sprouted badly.

I have had six out of the first twelve Le Conte pear trees that I put out to die outright from blight. They were on their own roots. For the past two seasons I have had no blight in my orchards. I have quite a number of pear trees on apple roots, but have never had any of them to make fruit.

As all the trees that I examined have put out roots from the Le Conte stock, I did not look below to see if there was any enlargement of the stock. From my experience in top-grafting the Le Conte, I have come to the conclusion that the affinity is not perfect with our old standard sorts.

I have not noticed that grafted trees were any more liable to disease than those on their own roots. In fact, I have lost more from blight that were on their own roots than of grafted trees. I have only 120 Le Contes in my orchard. Soil sandy with a red clay subsoil.

R. J. Winn, Judsonia, Arkansas, in Fruit Growers' Journal, January 1, 1890: "Some orchards of the Le Conte pear have blighted, especially where the trees are from four to five years old. As a consequence the Le Conte enthusiasm is waning."

Samuel Miller, Bluffton, Missouri, wrote me as follows: "While I am done with this pear tree, as far as raising fruit here is concerned, I believe there is a wide field for it in the way of stocks to work others on in the ground. If it grows so easily from cuttings, why don't they grow it so plentifully in the South as to supply the place of the French pear stocks?"

TEXAS.

Dr. W. W. Stell, Paris, Texas: Le Contes grafted on first class French and Belgian pear seedlings make fully as good growth with me as those grown on their own roots, and come into bearing one to two years sooner, and are fully as prolific, or more so. I have no Keiffers on Le Conte roots. I have not dug down to examine the roots, because I do not believe any one can tell for a certainty, by an examination of the roots, whether an eight or ten-year-old pear tree is on its own roots or on the stock it was grafted on. I do not believe because a central tap-root is wanting that that is any indication that the tree is not on the original roots it was grafted on. Many seedling pears, apples, etc., that are used as stocks are so branched when worked that they have no central tap-root to begin with. My grafted Le Contes and Keiffers are generally of a uniform size; where one is larger or smaller it can be explained by local causes widely different from what you indicate as the cause. I have observed all my life that pears when grafted or budded on pear seedlings do sprout from the stocks at times, and so do apples, Japan persimmons, etc.; but my Le Contes and Keiffers sprout less than the old sorts of pears. I am firmly of the opinion when pear trees are old enough to send up sprouts from the

stocks they should not be cultivated any longer. I know of no Le Contes or Keiffers, on their own roots or those grafted, planted where cotton dies. But I do know of a certainty that three out of five of my ten-year-old Le Contes that were propagated on their own roots—and bought at Thomasville, Georgia, where it would be considered a high crime to propagate any other way—did blight this year, and that badly, one so bad that the blight reached the ground and it was rooted up. The other two were cut off about four feet above ground, and twelve or fifteen inches below the affected parts, and the stumps of these two are perfectly sound to-day, and have made each from twenty to forty sprouts from two to four feet long.

There are several other fruit trees, viz., peaches, plums, quince, and Japan persimmons, within ten to thirty feet of these blighted pear trees, every one of which is as sound as a twenty-dollar gold piece. Six Le Conte trees are all I have on their own roots.

I have but little experience with pears on apple roots; but will say that one of my neighbors had a lot of pears grafted on apple roots that blighted and died the first or second year. Apple sprouts came up around them as thick as hops.

I have noticed the enlargements you refer to on the French stock, but do not believe it shows a non-affinity of the Le Conte for the French stock. It would certainly be a strange sight to see the stock of a pear tree smaller, or as small as the body. It would be abnormal, to say the least. There is nothing peculiar whatever in first class French pear stocks being larger than the tree above ground. It is the case with all kinds of fruit trees, grafted, budded, grown from cuttings or from seeds. Nature has wisely provided that the stock or foundation of a tree should be larger than the body. When first class French or Belgian pear seedlings are used as stocks, my experience is that they do not grow out of proportion to the bodies of the trees. It must be remembered, in all I have ever written on this subject, I have tried hard to impress the great importance of using only first class French and Belgian pear seedlings as stocks for all kinds of pears, and warned against the use of "Cheap John" stocks, such as the little wild pear growing all over France, and which does put in the most of its time in growing stumps and sprouts, and which can be bought for a mere song.

In a European trade catalogue I notice first class pear seedlings are worth there \$10 per thousand, which will cost laid down here about \$18 per thousand. And in the same catalogue I can buy pear stocks at \$10 per ten thousand, or \$1 a thousand. The temptation is great to take the latter. Man is but a weak animal at best.

I have no pears grafted on Le Conte or Keiffer stocks, but I have over 200 bearing Le Contes that were grafted on French stocks. About 5 per cent of these blighted this season, and about 25 per cent are affected with what I suppose to be root-rot. They are perfectly black from the ground up from one to six feet, with the same dark spots on the limbs as the Le Contes on their own roots have.

From my experience with the Le Conte, both on its own roots and grafted, if I ever become convinced that first class French and Belgian pear seedlings are unsuited as stocks for pears, I will grow stocks from the Keiffer to grow the Le Conte and other varieties on. The more I see of the Le Conte the more I am convinced of its unsuitableness as a stock for other varieties. Returning again to my orchard of 200 trees, I will say that it is badly situated, as the land does not drain well. Their surroundings are as follows: About thirty feet to the north is a row of Ben Davis apples running full length, twenty feet to the west a row of Keiffer pears on French stock, twenty feet to

the south a row of Japan persimmons, sixty-five feet east a row of mulberries. There is not a single diseased tree in all these adjacent rows.

H. M. Stringfellow, Hitchcock, Texas: 1. All my grafted trees have the Le Conte and Keiffer entirely above the ground. In productiveness I see no difference between grafted trees and those on their own roots after they come into bearing; but with me the Keiffer on its own roots fruits abundantly the fourth year, while on Le Conte or French stock it takes five or six years, and with some trees longer.

2. My grafted trees (on French stock) are a perfect nuisance, on account of suckers springing up everywhere, between the rows as well as around base of trees. This is probably more the case with my trees that were grafted high up than with those who have them set deeper.

3. Have never seen a Le Conte or Keiffer die after it gets to growing, except on certain very salty spots that occur on the coast. Root or top blight is unknown here.

4. No experience with apple roots for pear stocks.

5. Nearly all my trees on French stock show a very great enlargement of the stock, which amounts in many cases to a monstrosity, and the trees most affected are the smallest and least thrifty.

6. I have never seen a diseased Le Conte or Keiffer on its own roots, but have had nine grafted trees to die before they were six years old, and six or eight more badly diseased now, and in every instance the stock has been the only part of the tree affected, the Keiffer and Le Conte remaining green to the last. I saw twenty-five Le Contes on French stock at the Bayland Home, near Houston, about nine years old, last summer, and several had died just as mine did, and all were stunted and undersized, as well as suckering. I would advise all parties having these grafted trees planted shallow, if four years old or under, to take them up carefully, prune tops back severely, and set fifteen to eighteen inches deep. Both Le Conte and Keiffer transplant when old as easily as a cottonwood; and having moved four-year-old trees of both kinds, I see no harm done except the loss of a season's growth.

My subsoil is yellow clay, very compact, with water six to eight feet beneath the surface.

F. F. Ramsey, Mahomet, Burnet County, Texas: 1. We have noticed that Le Conte on its own roots is much more thrifty. Three years ago we planted one row of eleven trees of grafted Le Conte, and one of Le Conte cuttings. They have had the same treatment. Of the grafts but two are living, while all those on own roots are living and are fully twice as large as the grafts. We mention these two rows because we raised every tree of each row, and considered them an average.

2. A chance tree on French root sprouts.

3. We have had no Le Contes or Keiffers to die on Le Conte root.

4. We have not noticed any difference in the hardness of apple roots. We have not noticed the difference, if any, of the growth of other pears grafted on Le Conte and on French stocks.

5. In a few instances we have noticed the body of the tree larger than the stock below it. We do not think this any evidence as to the affinity or non-affinity of the two pears, but indicates that that particular stock is a slow growing variety, and to that extent is evidence against the use of French stocks.

6. We believe we have never lost a Le Conte on its own root, nor have we any other variety on Le Conte roots, but they (the others) are all young. We have had Le Contes lose several leading limbs from a disease that a writer in the Southern Journal of Horticulture describes and calls blight, but the trees seem as healthy now as ever. We supposed at the time that their death was caused

by caterpillars or sudden freezes, as we had been afflicted with both just before. We believe if a lot of French stocks were grafted with Keiffer and several of the old varieties of pears and planted on our soil, there would be a smaller per cent of the Keiffer alive at the end of six years than there would be of the other varieties at the end of fifteen or twenty years.

J. M. Alexander, Rockdale, Texas: 1. As far as my observation goes, the Le Conte and Keiffer on the Le Conte stock have been more vigorous with us than when on French stock. No pedigree Le Contes bearing here yet. A few trees on French stock bearing well. I find none of grafted Le Conte with any roots above the graft (three years since they were set). The first year they made no growth scarcely—very dry; the second year a very fair growth; and this year a thrifty growth, and about equal to Le Conte on own roots.

2. I have noticed some sprouting around eight-year-old trees grafted on French stock, but no serious case of it in our community.

3. I sold W. M. Fergusson, of our town, five hundred Le Contes on their own roots (pedigree), on which he has two years very vigorous growth since planting. The first year eight of them, after making a fine growth, died suddenly in the latter part of summer—bark turned black, and tree was brittle and easily broken before winter. This was on a spot where cotton dies some every year. Three or four others have died this year. We don't believe it to be regular pear blight, but think it the same thing which causes cotton to die. I have lost only two or three trees on my own place in three years; all of them were pedigree. They seemed to be affected in same manner. I had two very sick this year—leaves wilted and bark shriveled. I removed the earth and some bones I had around the roots, poured a half bucket of weak lye around them, and about same amount of wood ashes; then gave the body and branches two thorough washings with concentrated lye strong enough to bite my hands a little, and then threw back some fresh earth from a distance; all of which restored them to a normal state of health. One of them began a new growth in ten days; both made a good fall growth. As far as I have observed, the disease begins in the roots. One of the trees mentioned above had been set three years, the other set last spring.

4. I have never used any pear and apple roots except the whole seedling stock for grafting.

5. The French stock on which my three-year-old Le Contes are grafted are nearly all larger below the point of graft than the tree, and a few of them a fourth larger. I do not consider such condition an indication of perfect affinity between the stock and scion.

6. There are eight or ten Le Contes on their own roots in and around my town to one on French stock, and I know of no one on its own roots that has failed to make from a fair to a most vigorous growth; but it is common to see them on French stock that have set two or three years without making scarcely any growth.

My subsoil is a rich red clay, with a gray to a light sandy soil, and all trees thrive well on it.

G. A. McKee, Mount Selman, Cherokee County, Texas: Le Conte pears blight occasionally with us, but are not so subject to blight as some other varieties.

Soil here varies from stiff clay soil to a sandy loam, with a stiff red or yellow subsoil eighteen inches to three feet below the surface.

H. C. Hamilton, Whitesboro, Texas: The Le Conte shows some blight in some places, though not very much; mostly leaf blight. Root-rot is caused by a mineral substance coming up from below. The best preventive of this is under drainage.

D. G. Gregory, Alleyton, Texas: Out of 300 Le Conte trees I had three or

four that partially blighted in 1889. The dead limbs have thrown out new shoots near the trunk and seem to have recovered. I consider it bacterial and only temporary. My soil is a sandy loam, with a red clay porous subsoil with good natural drainage.

E. M. Kirkpatrick, McKinney, Texas: My experience and observation teaches me that Le Conte and Keiffer pears do best on their own roots. Where these pears are grafted on any other root and planted deep they are disposed to throw out their own roots and ignore the foreign roots.

I have noticed that pear trees sprout badly on the French stock.

I have not noticed any blighting or dying of Le Contes or Keiffers on their own roots. The apple root is as good as any for the pear, if the tree is planted deep enough to ignore the apple root.

I have often noticed the enlargements you speak of, and consider them a sign of non-affinity.

I consider trees more subject to disease and short lived when grafted on the French stock than when grown on the Le Conte or Keiffer roots. The soil is black waxy, with yellow clay subsoil.

J. W. Stubenrauch, Mexia, Texas: Our soil is from ten inches to two feet in depth; subsoil red clay. The difference in growth between Le Conte and Keiffer on their own roots and those on French stock is not material. Have not found any on the French stock that have taken root above graft.

Pear sprouts from the French stock are very numerous and are a nuisance.

Have had as yet no blight on any Le Conte nor Keiffer, neither on own roots nor grafted stock. Apple roots are a failure for pears to grow on.

The enlargement at point of union between graft and stock on Le Conte and Keiffer is frequently present with us, and we certainly deem it a defect in the union.

E. S. Peters, Calvert, Texas: It is my belief and others in this vicinity that our pear trees do not die from pear blight, but from root-rot, as cotton does on some ground in my orchard. I am well pleased with Japan plums and Le Conte pears.

Otto Locke, New Braunfels, Texas: The Le Conte on its own roots makes a growth of eight to ten feet in one year, but on French stocks they make only a growth of one to two feet in one year.

Yes, a few of my pears on French stocks sprout from the roots.

I have not noticed any blighting or dying of Le Contes or Keiffers on their own roots. I have not noticed the enlargements of the French stock you speak of. I believe trees grafted on French stock more subject to disease than those grown on Le Conte or Keiffer roots.

All my trees are young, from two to six years old. I find that all varieties on Le Conte roots grow very rapidly, but on French stocks they make a very poor growth. My soil is black bottom land.

J. S. Kerr, Sherman, Texas: I have not noticed as to which trees fruit most, whether grafted on Le Conte or French stock.

I notice enlargement and tendency to sprout at the union of Le Conte with French stock. Have not noticed any blighting of Le Contes on their own roots.

On four-year Le Contes grafted on apple roots I notice the pear discards the apple root and throws out its own roots above, and the apple root stops growing and is of no effect. The enlargement looks like the want of affinity.

I have not noticed that grafted trees are more subject to disease than those on their own roots.

John B. Long, Rusk, Cherokee County, Texas: Le Conte pears have been grown here about five years, and have shown no blight up to this time. We

have a gray and red sandy soil, red clay subsoil, which has a peculiar and excellent adaptation to the successful growth of fruits.

D. J. Eddleman, Denton, Texas: I have never had a case of pear blight on my place. My Le Contes and Keiffers are now six years old, and up to this time I have not had but one Keiffer pear and no Le Conte. They have set crops for three years, but fall off in a few weeks, while Bartlett and Duchess hold their fruit. The trees grow finely, but they don't bear. My Le Contes were on apple roots at first, but are now on roots put out from above the grafts. My Keiffers are said to be on Le Conte roots, but I think they are on French stock. None of them have sprouted. I have cultivated the orchard for six years in corn and cotton. All the root-rot I ever met came from too much water settling about the roots in hot weather.

C. H. Brossmann, Bellville, Texas: I prefer grafted trees, if graft is set three or four inches below surface of soil; they will grow slow for a few years but will make up for it later, and in time come near the natural form of a seedling pear tree. They bear earlier, and fruit is more uniform and larger than on trees from cuttings. I have fifty Bartlett trees worked on the Le Conte five years old, and last summer during the rainy and windy season I had to cut the tops off to save them, because they had no tap and side roots to hold them. The only objection I have to the Le Conte is its rampant growth. I find it a job to give the tree the needed spreading form by a course of regular pruning to an outside bud before the bearing age. My choice for several years has been the Keiffer. As to sprouts under the pear trees, I will say that I put out some grafted Rostiezer pears in 1867, and by cultivation and rain the soil was washed away from the roots to such an extent that I injured the roots with the plow, and since sprouts have appeared; and I think any other pear tree will sprout under the same circumstances.

My soil is dark sand, with all mixtures of subsoils in different parts of the orchard, except some red clay, which I think best for fruit.

E. Crew, Hempstead, Texas: No Le Contes here have shown any blight, but are vigorous trees. We have a sandy loam with clay subsoil from six inches to ten feet from the surface.

SOME PARASITIC FUNGI OF TEXAS.

WITH NOTES.

BY H. S. JENNINGS,

ASSISTANT IN HORTICULTURE AND BOTANY.

1. *ÆCIDIUM CALLIRRHÆ*, E. & K. On the leaves and sometimes on the petioles and stems of *Callirrhæ involucrata*. Not uncommon in April and May; thickening the tissues and causing them to turn red; sometimes nearly destroying the leaves.

2. *ÆCIDIUM HOUSTONIATUM*, Schw. On Bluets (*Houstonia minima*). Very common after the flowers have fallen, in February and March. Plants affected are somewhat taller than those unaffected, and the growth is noticeably more erect, so that they are easily distinguished.

3. *ÆCIDIUM ZANTHOXYLI*, Pk. Abundant on the leaves of the Prickly Ash (*Zanthoxylum Carolinianum*) in April and May.

4. *ACTINONEMA ROSÆ* (Libert), Fries. Black Spot of Rose. Causes black spots on the leaves of cultivated roses, injuring their appearance and probably harmful otherwise. Observed at College Station in February; very common in many parts of the State.

5. *ASCOCHYTA SMILACIS*, E. & M. On leaves of Green Brier (*Smilax tamnoides*), causing numerous light colored or pinkish spots, noticeable on both sides; common in fall.

6. *CÆOMA NITENS*, Schw. Orange Rust of Blackberry. Exceedingly common and conspicuous on the Dewberry (*Rubus trivialis*) and cultivated Blackberries and Raspberries, covering the lower side of the leaves with the mass of orange colored spores, and bursting through the bark on the canes. Very injurious, and is becoming a great drawback to blackberry culture in this State. Of the common varieties, Kittatinny, Early Harvest, and Erie are most affected. It has not yet been found on the Dallas. On the wild Dewberry this fungus is sometimes itself covered and almost destroyed by the purple spores of *Tuberculina persicina*, Ditm.

7. *CERCOSPORA ALTHÆNIA*, Sacc. Causing white spots on the leaves of *Modiola multifida*, in February and March. Not particularly injurious to this plant, as it occurs mostly on weakened or dying leaves.

8. *CERCOSPORA BETICOLA*, Sacc. Causing numerous brown spots on leaves of cultivated beet (*Beta vulgaris*) in January. Not common nor very injurious here.

9. *CERCOSPORA BRUNKII*, Ell. and Galw., *n. sp.* On Geraniums (*Pelargonium*, sp.) First noticed in the College greenhouse about the middle of December, 1889, by Prof. Brunk, on many of the Geraniums of different varieties, causing reddish-brown dead spots on the leaves; since that time it has been exceedingly abundant, making it difficult to grow these plants with satisfaction. The disease spread rapidly, the spots increased in size and number until many leaves were destroyed, and some of the plants almost defoliated. Not a single variety seemed to be free from the disease. On the ivy-leaved Geranium (*Pelargonium peltatum*) the fungus varied slightly from the

type, but the outward effects are similar. A *Cercospora* much resembling this does considerable damage to Calla Lilies in the greenhouse also.

10. *CERCOSPORA CATALPÆ*, Wint. Causing numerous dark spots on the leaves of the Catalpas (*Catalpa speciosa*) in the College arboretum, in November. The spots become white, from the thinness of the leaf tissue, after a time. Common and considerably injurious.

11. *CERCOSPORA CHENOPODII*, Fres. On leaves of Wormseed (*Chenopodium ambrosioides*, var. *anthelminticum*), causing small white spots; not injuring it appreciably.

12. *CERCOSPORA LIPPILÆ*, E. & E. On Fog fruit (*Lippia nodiflora*), causing small white spots on the leaves. January.

13. *CERCOSPORA OCCIDENTALIS*, Cke. Causing numerous brown spots on the leaves of the Wild Coffee Plant (*Cassia occidentalis*); very abundant in December, 1889.

14. *CERCOSPORA PERSONATA*, B. & C. On Wild Coffee Plant (*Cassia occidentalis*). Not evidently distinguishable, outwardly, from No. 9.

15. *CERCOSPORA SMILACIS*, Thun. On Green Brier (*Smilax tamnoides*), causing light colored spots; not very common or noticeable.

16. *CERCOSPORA TEXENSIS*, E. & G. On leaves of Green Ash (*Fraxinus viridis*), often almost covering them with brown spots, becoming white. Common and injurious, in the fall.

17. *CERCOSPORA TOXICODENDRI*, El. On Poison Ivy (*Rhus toxicodendron*); causing numerous small circular brown spots on the leaves. Common; not particularly injurious.

18. *CERCOSPORA VIOLÆ*, Sacc. On Violet (*Viola cucullata*). Observed in November, 1889, forming large white spots on the leaves. Not common, but very injurious.

19. *CERCOSPORA*, *n. sp.* On Begonia. In December, 1889, a disease appeared on a certain class of Begonias in the greenhouse, forming white spots in the centre of larger brown patches on the leaves, causing the spots to die and rot out or the whole leaf to fall. Considerable damage is thus done. Mr. J. B. Ellis, of New Jersey, to whom specimens were sent for determination, says it is probably a new species of *Cercospora*, but it has not been named.

20. *CLADOSPORIUM FULVUM*, Cke. On Tomato (*Lycopersicum esculentum*). In December, 1889, this exceedingly injurious fungus was noted on a large number of Tomato plants in the greenhouse, of the Dwarf Champion variety; nearly all the leaves being fairly covered on the under side with a thick lavender-colored down. As the disease progressed the fungus turned brown, the leaves soon after turning yellow and beginning to wither; spores falling like dust whenever the leaves were shaken. No tomatoes were produced, and the plants, becoming worthless and nearly dead, were removed and thrown away.

21. *CLADOSPORIUM VITICOLUM*, Viala. Grape leaf blight. This well known pest is exceedingly common on grapes leaves at College Station and in all parts of Texas. It occurs on both sides of the leaves, the irregular brown spots often covering almost the entire surface. It does considerable damage to the foliage, especially in wet seasons, but does not affect the fruit so far as known. It affects the Riparia family of grapes more than any other, the varieties Clinton and Bacchus being affected most.

22. *COLEOSPORIUM ELEPHANTOPODIS*, Sz. Bright yellow "rust" on leaves and involucre of Elephant's Foot (*Elephantopus Carolinianus*). Common in summer.

23. *COLEOSPORIUM IPOMOEÆ*, Sz. On Moon flowers (*Ipomoea bona-nox*) and Morning-glory (*Ipomoea purpurea*). Nearly covering the under side of the leaves

with bright orange spores; very noticeable. Observed in November, 1889, on two plants only.

24. *COLEOSPORIUM SONCHI* (Pers.), Lev. On the lower side of the leaves of Rosin Weed (*Silphium scaberrimum*) in spring. Common.

25. *COLEOSPORIUM VERNONIE*, B. & C. On the leaves of Iron Weed (*Vernonia* sp.); similar in appearance to No. 24. Common; September, 1889.

26. *COLLETOTRICHUM BROMI*, n. sp. On leaves of Rescue Grass (*Bromus unioloides*), forming thin spots, on which the black fungus is very noticeable. Weakens the tissues, causing them to break away, leaving dead spots or holes in the leaves. First collected April 2, 1890.

27. *CYSTOPUS BLITI*, Lev. Small elevated white or yellowish spots on the under surface of the leaves of Pig Weed (*Amarantus retroflexus*). Common; somewhat injurious to the plant; June, 1889.

28. *CYSTOPUS PORTULACÆ*, Lev. On Purslane (*Portulaca oleracea*), causing elevated white spots on the upper side of the leaves. Common and of some value, as it is quite injurious to this troublesome weed. June, 1889.

29. *DIORCHIDIUM BOUTELOUÆ*, n. sp. III. On Gamma Grass (*Bouteloua racemosa*). This new species of this rare and interesting genus was discovered on specimens of *Bouteloua racemosa* collected in December, 1889. This genus differs from the closely related *Puccinia* in having the teliospores divided by perpendicular or oblique instead of horizontal septa. In this species the septum arises in the larger number of spores from the end of the pedicel, but as in other species, the position of the septa is not constant, the pedicel arising from any corner of the spore, though so far as observed never from the end, as in *Puccinia*. The sori are elongated, black, and occur on the upper part of culm and sparingly on the leaves. Only the teliospores were found.

30. *ENTYLOMA PHYSALIDIS* (Klachbr. and Cke.), Wint. Dark swollen spots on the leaves of Ground Cherry (*Physalis pubescens*). April.

31. *ERYSIPHE CICHORIALEARUM*, DC. On Cockle Bur (*Xanthium strumarium*), Rag Weed (*Ambrosia artemisiifolia*), Vervain (*Verbena officinalis*), and cultivated Verbenas. This is exceedingly common, and does considerable damage to Verbenas in the greenhouse. Sulphur dusted on the leaves generally destroys it.

32. *ERYSIPHE COMMUNIS*, Wallr. On *Enothera sinuata*. Very common.

33. *ERYSIPHE GRAMINIS*, DC. On Rescue Grass (*Bromus unioloides*) and Crab Grass (*Panicum sanguinale*). Very common in March and April on the Rescue Grass, the conidial stage covering the leaves with a white frosty appearance, and by the time the perithecia appear many of the leaves turn white and are dead. Very injurious, where the grass grows in damp or shady places.

34. *EXOASCUS DEFORMANS*, Berk. Leaf Curl. Thickening, curling, and variously distorting the leaves of the Peach. Injurious. Observed on only one tree, in April, 1888 and 1889.

35. *GLEOSPORIUM DECIPiens*, E. & E. Causing numerous brown spots and patches on the leaves of the Green Ash (*Fraxinus viridis*). Common and injurious. It occurs mostly on the leaves at the same time as another fungus, *Piggotia fraxini*, B. & C.

36. *GLEOSPORIUM FRUCTIGENUM*, Berk. Bitter Rot of Apple. Observed in June, 1889, at Tyler, Denison, and Pilot Point; causing yellow spots on the leaves, and often destroying nearly a whole crop by causing the apples to rot. The rot may be known by the ring of small black pustules on the surface of the rotten part. Ben Davis and other fall and winter varieties are most affected; early summer varieties are exempt.

37. *GLEOSPORIUM LAGENARIUM*, Pass., var. *FOLICOLUM*, E. & E. On Watermelon. This was observed only once at the College, causing numerous

black spots on the leaves of a watermelon vine, and injuring it severely. It is not improbable, however, that this is the disease which has been causing much damage to watermelon vines all over Texas, causing the leaves to die first near the roots and then follow down the vine toward the growing end. It first appears in the latter part of June and continues till frost.

38. *GYMNOSPORANGIUM MACROPUS*, Lk. Cedar Apple. Very common on the Red Cedar (*Juniperus Virginiana*). Causes large bunches about three-fourths of an inch in diameter to form on the limbs; these, in the spring after heavy rains, are covered with long jelly-like tongues standing out in all directions, on which the spores are borne. These spores cause the Apple Leaf Rust known as *Ræstelia pyrata*, Schw.

39. *HELMINTHOSPORIUM RAVENELII*, Curtis. On Smut Grass (*Sporobolus Indicus*), covering the inflorescence with a black spongy mass of spores; scarcely a mature panicle of this grass to be found free from it. Apparently not injurious to the grass as a forage plant, as it is too old and wiry for pasturage when the fungus appears.

40. *HELMINTHOSPORIUM SORGHII*, Schw. Very numerous elongated red blotches on the young fall growth of Johnson Grass (*Sorghum halapense*). Common in December and January; probably would be considerably injurious if the grass were not soon killed by the frost.

41. *HENDERSONIA FOLIORUM*, Fckl. Causing circular white spots on the leaves of the Pear, in November; injurious. Occurs in connection with several other fungi, as *Sphaeropsis malorum*, *Phyllosticta pyrina*.

42. *LÆSTADIA BIDWELLII*, Viala & Ravaz. Black Rot of Grape. Very common on cultivated grapes in Texas, and exceedingly injurious unless its attacks are prevented by the use of the Bordeaux mixture. See Bulletin No. 8, December, 1889. The stage known as Leaf Spot (*Phyllosticta labruscae*, Thuem.) is very common on wild grapes (especially *Vitis candicans*), and the Virginia Creeper (*Ampelopsis quinquefolia*).

43. *LEPTOTHYRIUM DRYINUM*, Sacc. On the upper side of the leaves of Water Oak (*Quercus aquatica*) and Post Oak (*Quercus obtusiloba*), forming dead spots. Common.

44. *MELAMPSORA POPULINA*, Lev. On Cottonwood (*Populus monilifera*) and Balsam Poplar (*Populus balsamifera*). Very common in fall, forming very abundant reddish-yellow spots on both sides of the leaves, but much more abundant on the lower side. A species of *Fusarium* parasitic on the sori of the *Melampsora* was found in the specimens from *P. balsamifera*.

45. *MELAMPSORA SALICINA*, Lev. On Black Willow (*Salix nigra*). On both sides of the leaves; similar in appearance to No. 44. Rather common in fall.

46. *MICROSPHÆRA RAVENELII*, Berk. On Honey Locust (*Gleditsia triacanthos*). Covering the upper surface of the leaves of one of the young trees in the College arboretum with the dense white mycelium, interspersed with the black perithecia. November, 1889.

47. *MICROSPHÆRA SYMPHORICARPI*, Howe. On *Symphoricarpos vulgaris*. Very common in May.

48. *PERICONIA PYCNOSPORA*, Fries. Dark spots on the leaves of the California Privet (*Ligustrum Californicum*) and *Hibiscus grandiflorus*; not abundant.

49. *PERONOSPORA CUBENSIS*, B. & C. On Gherkin (*Cucumis anguria*). Appearance first noticeable in October, by yellowish patches showing undefinedly on the leaves; these slowly gathered together, forming yellowish-brown dead spots. Observed only on two large vines growing in shady places; ex-

ceedingly injurious to these, destroying most of the leaves. Will probably become a serious pest if it spreads to the cucumbers, as it has in other places.

50. *PERONOSPORA ENTOSPOREA*, B. & Br. On the lower side of the leaves of very young Cone-flower (*Rudbeckia fulgida*). Not common. March.

51. *PERONOSPORA GERANII*, Pk. Covering the under side of the leaves of the Wild Cranesbill (*Geranium Carolinianum*) with a thick white felt, causing them to wither and die; very common.

52. *PERONOSPORA PARASITICA*, Pers. Cabbage Mildew. On pods and stems of Wild Cress (*Arabis*, sp.). Not common.

53. *PERONOSPORA VITICOLA*, D By. Downy Mildew of Grape, Brown and Gray Rot of Grape. One of the commonest diseases of the grape in Texas; exceedingly abundant in the College vineyard last fall. Very injurious, if no means of preventing its ravages are employed. See Bulletin No. 8, December, 1889.

54. *PHLEOSPORA MORI*, Lev. Causing brown, dead spots on the leaves of the Russian Mulberry (*Morus tatarica*) and *Morus multicaulis* in fall.

55. *PHRAGMIDIUM MUCRONATUM* (Pers.) Lk. On Rose. Stage II. Red rust on the lower side of the leaves. Stage III. Black several-septate spores, barely noticeable to the naked eye, appearing later in the same sori with the spores of stage II. Observed at Tyler and McKinney, Texas; common where observed.

56. *PHYLLACHORA GRAMINIS*, Pers. On Wild Oats (*Chrysopogon nutans*), Beard Grass (*Andropogon saccharoides*), and *Panicum dichotomum*. Forming black swollen spots on the leaves; very common, but not particularly harmful, as it appears mostly on leaves which are old and dying.

57. *PIGGOTIA FRAXINI*, B. & C. Small black spots on the lower side of the leaves of Green Ash (*Fraxinus viridis*). Common and somewhat injurious.

58. *POWRIGHTIA MORBOSA* (Schw.), Sacc. The well known Black Knot of Plum; rare. Observed once in North Texas and once at College Station.

59. *PUCCINIA CONCLUSA*, Thun. Stages II and III. On Sedge (*Cyperus* sp.). Very abundant in the fall on the leaves and culms of two or three species of *Cyperus*.

60. *PUCCINIA CORONATA*, Corda. Oats Rust Stages II and III. On Oats (*Avena sativa*). Exceedingly abundant with *Puccinia graminis*, the two causing whole fields of oats to turn yellow soon after beginning growth in the spring. These are the principal drawbacks to the cultivation of oats in this section. The crop in 1889 was scarcely fit to cut, even for forage, it was rusted so badly.

61. *PUCCINIA CRYPTOTÆNIÆ*, Peck. Stage III. On Honewort (*Cryptotaenia Canadensis*). Observed but once, August, 1889.

62. *PUCCINIA DICHONDREÆ*, Berk. Stage III. On *Dichondra repens*. Very common in spring.

63. *PUCCINIA EMACULATA*, Schw. Stage III. On False Red Top Grass (*Triodia sesleroides*) in fall.

64. *PUCCINIA GRAMINIS*, Pers. Grass Rust. Stages II and III. On Oats (*Avena sativa*), Wild Oats (*Chrysopogon nutans*), Broom Sedge (*Andropogon dissitiflorus*), American Canary Grass (*Phalaris intermedia*), and *Eragrostis capillaris*. Common, and causing great damage to the oat crop.

65. *PUCCINIA PRUNI-SPINOSA*, Pers. Peach and Plum Rust. Stage II. On Peach and Plum (cultivated and wild). Stage III. On cultivated and wild plums (*Prunus chicensa*). A serious pest, exceedingly abundant, causing the leaves to fall prematurely. The Bordeaux mixture has been found efficacious in preventing its injuries. While the *Teleutospore* stage is common on the Plum, it seems never to appear on the Peach. Plums of the Chickasaw vari-

eties are most affected. It has been observed in North, East, and Central Texas.

66. PUCCINIA PURPUREA, Cke. Stages II and III. On common Sorghum (*Sorghum saccharatum*) and Johnson Grass (*Sorghum halapense*). Exceedingly abundant, particularly on the former host, causing very numerous red pustules. Considerably injurious, causing the leaves to wither and die prematurely. November.

67. PUCCINIA SESSILIS, Schneid. Stage I (*Æcidium alliatum*). On *Allium striatum*. Occurring in March on the leaves and scapes. In nearly all specimens found the *Æcidium* itself was almost covered and destroyed by another parasitic fungus, *Tuberculina persicina*, Ditm.

68. PUCCINIA SMILACIS, Sz. Stages II and III. On leaves of Green Briar (*Smilax tamnoides*). Very common. The sori of this fungus are generally infested by another, *Darlucania filum*, Cast.

69. PUCCINIA TANACETI, DC. Stage II. Rust abundant on the lower side of the leaves of the Sunflower (*Helianthus annuus*). July.

70. PUCCINIA VEXANS, Farlow. Stage II. On Gamma Grass (*Bouteloua racemosa*). Not common.

71. RAMMULARIA OBOVATA, Fckl. Causing circular brown, ultimately dead spots on the leaves of Dock (*Rumex obtusifolius*). Occurs mostly on the lower weakened or dying leaves.

72. RAVENELIA TEXANUS, Ell. & Galw. n. sp. On an undetermined leguminous plant—collected after the flower and fruit were gone—probably a *Desmanthus* or *Cassia*. A black fungus, entirely covering the lower side of the leaves; conspicuous. November, 1889.

73. ROESTELIA AURANTIACA, Pk. On the leaves, peduncles, calyxes, and fruit of Hawthorn (*Crataegus spathulata*); swelling and distorting them; abundant in spring, in the spermogonial stage.

74. SPHACELOMA AMPELINUM, D By. Anthracnose of Grape. This well known pest is not uncommon on grapes in the College vineyard and in many parts of Texas. Exceedingly injurious. Attacks rapid, rank growing varieties, such as Black Spanish, Louisiana, Duchess, etc.

75. SPHÆRELLA FRAGARIE, Sacc. White Rust of Strawberry. Abundant in spring on strawberry plants in the College garden, forming white spots with a brown or reddish border on the upper side of the leaves. Considerably injurious to some varieties. Charleston and Wilson suffer most.

76. SPHÆROTHECA PANNOSA, Lev. Rose Mildew. Conidial stage (*Oidium leucoconium*, Desm.) not uncommon on roses, injuring them severely, destroying the young leaves in spring.

77. STIGMELLA PLATANI, Fckl. Giving a brown, rusty appearance to the leaves of Sycamore (*Platanus occidentalis*). Summer, 1889.

78. SYNCHYTRIUM FULGENS, Schrr. Minute yellow spots on the stem, petioles, and leaves of *Eriogonum sinuata*, distorting them and injuring the growth of the plant. Exceedingly common. January to May.

79. SYNCHYTRIUM, n. sp. On *Engelmannia pinnatifida*. This may possibly be *Synchytrium taraxaci*, D. By. & Wor.; it was submitted to Mr. Ellis, of New Jersey, and a name is not given till he decides definitely concerning the identity of the two.

80. TILLETIA RUGISPORA, E. & G., n. sp. On *Paspalum plicatulum*. Filling the spikelets, but not very noticeable; the spikelets appear of a darker brown and are distorted.

81. UNCINULA CIRCONATA, C. & P. On Maple leaves (*Acer dasycarpum*). Observed at Tyler in October, 1888.

82. UNCINULA SPIRALIS, B. & C. Powdery Mildew of Grape. Not un-

common on leaves of the grapes in the College vineyard. A Golden Chasselas vine in the greenhouse was almost covered by it and nearly all the leaves destroyed in November, 1889. Small black dots on both sides of the leaves; not noticeable except where numerous.

83. *UREDO FICI*, Cast. Small dark-brown powdery spots opening on the lower side of the leaves of the Fig (*Ficus carica*.) Observed only on two young trees in December.

84. *UREDO HELIANTHI*, Sz. Brown pustules on the lower sides of the leaves of the Sunflower (*Helianthus annuus*). Summer.

85. *UREDO OXALIDIS*, Lev. On Wood Sorrel (*Oxalis violacea*.) Very abundant on the lower side of the leaves, the bright orange-red spores often completely covering them, stopping the growth of the plant. Hardly a specimen of this plant to be found without the fungus. Spring.

86. *UROMYCES APPENDICULATUS*, Pers. Bean Rust. Stages II and III. On Cultivated Bean, at Hempstead, Texas. Stage III. On *Phaseolus*, sp. Forming dark brown or black powdery spots; abundant on both sides of the leaves.

87. *UROMYCES DACTYLIDIS*, Oth. Stages II and III. On Wild Barley (*Hordeum pratense*). North Texas; summer, 1889. Stage III. On Small Fescue Grass (*Festuca tenella*). College Station; spring, 1890. Sori small, black.

88. *UROMYCES POLYGONI* (Pers.) Fckl. Stage II. Small inconspicuous brown spots on both sides of the leaves of Knot Grass (*Polygonum* sp.).

89. *UROMYCES RUDBECKIÆ*, Arthur and Holway. Stage III. On Cone Flower (*Rudbeckia fulgida*). Forming definite light brown spots on the lower sides of the leaves. Spring; not common.

90. *UROMYCES TEREBINTHI*, DC. Stage III. On Poison Ivy (*Rhus Toxicodendron*). Brown rust on both sides of the leaves. Not common.

91. *UROMYCES TRIFOLII*, DC. Clover Rust. Stages I, II, and III. On Carolina Clover (*Trifolium Carolinianum*). All three stages exceedingly common; the *Æcidium* from January till April; stages II and III all the rest of the summer and fall. Injurious.

92. *USTILAGO APICULATA*, Ell. & Galw., n. sp. On Beard Grass (*Andropogon saccharoides*). Black smut on the inner side of the sheaths, near the joint; extending scarcely more than an inch or two above it. Not conspicuous; probably not injurious.

93. *USTILAGO MAYDIS*, Corda. Corn Smut. Not noticed as being very common; more common on the black waxy lands of North Texas.

94. *USTILAGO SEGETUM*, Lk. Black Smut of Grain. On Oats and Barley; common, often causing a considerable per cent of loss in these crops.

95. *USTILAGO SYNTHESISMÆ*, Schw. On Crab Grass (*Panicum sanguinale*), converting the spikes into a black mass of spores, entirely destroying the seeds of the plant. Not common; observed at Paris and College Station, Texas.

The fungi in this list were collected, except where otherwise stated, at College Station, between the months of November, 1889, and April, 1890. While not a long list, it contains some of much economic importance and eight new species, besides extending the hosts of several. For the determination of many of these species and various courtesies, I wish to acknowledge my obligations to Profs. B. T. Galloway and D. G. Fairchild, of the Section of Vegetable Pathology, Washington, D. C., and to Mr. J. B. Ellis, of Newfield, N. J. Also to Prof. T. L. Brunk, to whom should be credited many of the notes as to their economic importance; also the observation and collection of several species, especially those collected in different parts of the State.

TEXAS AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 10,
MAY, 1890.

FEEDING EXPERIMENT

AGRICULTURAL AND MECHANICAL COLLEGE,
College Station, Brazos County, Texas.

BY ORDER OF THE COUNCIL: F. A. GULLEY, DIRECTOR.



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THE CATTLE INTERESTS.

The general improvement of the cattle business of the country after several years of depression, estimated by a Chicago livestock reporter as being equal to one dollar per head gross weight in that market over prices ruling a year ago, and the fact that cattle slaughtering plants are soon to be in operation in this State, from which beef will be exported direct, are matters of great importance to the cattle men of Texas.

It is admitted by stockmen of the country that Texas surpasses all other States in its advantages for breeding cattle, but the idea is common with Texas cattle men that Texas cattle must be grown and fed in some other State.

The establishment of slaughtering houses in the State calls for a constant supply of fat cattle during the year. The amount of beef that the trade will take from the Texas houses will be governed by the number of good beeves the stockmen will supply them.

In the feeding experiments begun at the Experiment Station a year ago we have attempted to show that cattle may be fattened as successfully and at as low cost in Texas as in any part of the country.

In this Bulletin we give the result of our work for the past winter, and place it before our readers in the simplest form, free from technical expressions and all discussions not of interest to the practical cattle feeder.

We append letters from several States relating to cattle feeding.

TEXAS AGRICULTURAL EXPERIMENT STATION.

FEEDING EXPERIMENT NO. 2.

BY F. A. GULLEY AND J. W. CARSON.

This experiment is a continuation of the feeding experiments inaugurated last winter, and reported in Bulletin No. 6.

Three questions were asked of the cattle and feed-stuffs employed in the test made last winter:

1. Is it profitable and practicable to shelter range cattle in feeding?
2. What feed-stuffs that can be supplied in the State give best returns for cost?
3. Can the native Texas steer be fed profitably?

Fifty-five head of cattle were fed on different rations, made up of corn, hay, cotton seed raw and cooked, cotton seed hulls, cotton seed meal, and silage. The results showed that range steers may be dehorned and fed loose under a shed, crowded together like sheep, successfully, and that cost of certain food consumed is much less than increased value of steers from gains made in weight at selling prices of food and steers.

In regard to comparative results from different feed-stuffs, silage and cotton seed hulls for roughness, and cooked cotton seed and cotton meal, with or without corn, made more rapid gain than hay and corn, and at less cost. Cattle not sheltered consumed more food, and made less gain in weight, than cattle fed under sheds.

From the result of this and other experiments, we assume that, except in favored and exceptional hay producing sections, cotton hulls in the vicinity of the oil mills, and corn and sorghum silage elsewhere in the State supply rough fodder in the cheapest form to the cattle feeder as the basis of food rations; and we also assume that the best method of handling the cattle is to saw the horns off close to the head, and feed the cattle under shelter, unless the winter is exceptionally dry.

An examination of the tables in Bulletin No. 6 will show that steers dehorned and fed under shelter made larger gains than steers not dehorned and not sheltered, and at less cost for food.

Several questions are put to the cattle and feed-stuffs in this experiment, but the two leading questions are:

1. What is the best to feed with cotton hulls?
2. What is best to feed with silage?

Incidentally we ask:

- a. If sweetening the ration will make it more palatable to cattle?
- b. Is corn silage a better cattle food than dry corn fodder?
- c. What is the comparative value of cotton seed and cotton meal for feeding?
- d. Is corn the best grain to feed with corn silage?
- f. Will changing the ration stimulate the appetite and cause cattle to fatten more rapidly?
- g. Will hogs do as well running after silage and cotton meal fed cattle as after hay, corn, and cotton seed fed cattle?
- h. Will cotton seed improve the corn and hay ration?
- i. Is cotton hulls and cotton meal a good food to fatten sheep?

CATTLE USED.

Two lots of cattle were used. Lot 1, 50 head raised in Williamson County, twos and threes, all having some Shorthorn or Hereford blood, and in good condition, but never having been handled, nor had extra care or feed.

Lot 2, 22 head, was purchased in Waller County, with the expectation of getting native range cattle to compare with steers having a dash of improved blood. The cattle were ordinary, in rather thin condition, as is shown by the weights, pens 12, 13, and 14, but they were not so wild as the Williamson County steers, having, as we learned later, grazed around the settlements and learned to eat. They were from 4 to 6 years old.

As soon as received the cattle were dehorned, and put into the pens to feed. The three and four steer lots occupied pens 10x14 feet, with an outside open yard twice as large. The six and eight steer lots, pens 14x20 feet, outside yards same proportion. The ten steer lots in pens 10x30 feet, with outside yards 30x30 feet. Pen 14 was not dehorned, and the steers were fed in an open dry yard. The cattle were not tied.

Lot 1 was fed 90 days; lot 2, 79 days. At the end of this period of feeding there was considerable difference in the gains made by the different pens from different rations. (See tables 6 to 20.) To even the cattle up for shipment the divisions between the pens were removed, the cattle turned together, and all fed alike, but with a combination of feed-stuffs different from that of the first period.

The effect of greater freedom, change and variety of food is shown in the *rapid increase, even after the cattle had been fed 79 and 90 days, and made an average gain of over 200 pounds per head.* See gains, Tables 6 to 19, and Summary 1.

This feeding experiment was planned with special reference to testing the principal available feed-stuffs of the State under as near similar conditions as may be provided by men feeding for profit as possible.

In testing a number of different rations, however, we can not avoid artificial conditions to some extent, but they are such as interfere with securing the best results in increase in weight. Confining steers in small pens is not the best method of handling them; nor is it desirable to use the same feed-stuffs without change for the entire period of feeding.

An examination of the weights of the cattle, after having been fed sixty days, will show that the gain per day as a rule decreased the longer time they were fed, and some of the pens lost in weight from the 80th to the 90th day (see Table No. 21), yet, as soon as the steers were given opportunity to move around and a greater variety of food, they commenced to gain in weight at once, making in some pens a larger gain per day from the 90th to the 110th day than during the first period of feeding.

The frequent weighing of cattle disturbs them and interferes with rapid gain. Nevertheless the increase in weight of the two lots, an average of 246.5 pounds in 110 days with one, and 286.1 pounds in 90 days with the other, is very good, and especially so where some ten different rations have been fed.

FIRST LOT OF STEERS.

Pen 1—6 Steers.

Consumed per head in 90 days:			
279.68 lbs. corn fodder, at \$5 per ton	.....	\$	70
826. " silage, at \$2 per ton	.....		83
717.72 " cotton seed, cooked, at \$7 per ton..	.....	2	51
27.84 " hay	.....		08
			<hr/>
			\$4 12
Average weight, 793.33 pounds. Average gain, 161.6 lbs. Gain per cwt, 21 lbs. Value of food consumed for each pound gained, 2.55 cents.			

Pen 2—4 Steers.

Consumed per head in 90 days:			
2159.75 lbs. silage, at \$2 per ton	.....	\$2	15
380.27 " corn and cob meal, at 40 cents per bushel for the corn	.....	2	17
323.75 " cotton meal, at \$20 per ton	.....	3	23
			<hr/>
			\$7 55
Average weight of steers, 692.5 lbs. Average gain per head, 163.75 lbs. Gain per cwt, 23.9 lbs. Value of food consumed per each pound gained, 4.6 cents.			

Pen 3—6 Steers.

Consumed per head in 90 days:			
2018 lbs. silage, at \$2 per ton	.....	\$2	02
685 " cotton seed, cooked, at \$7 per ton...	.....	2	39
359 " hay, at \$6 per ton	.....		11
			<hr/>
			\$4 52
Average weight of steers, 755.8 lbs. Average gain per head, 164.1 lbs. Gain per cwt, 21.8 lbs. Value of food consumed per pound gained, 2.7 cents.			

Pen 4—4 Steers.

Consumed per head in 90 days:			
3401.6 lbs. silage, at \$2 per ton	.....	\$3	40
507.55 " cotton meal, at \$20 per ton	.....	5	08
3.62 " gallons molasses, at 20 cents	.....		72
			<hr/>
			\$9 20
Average weight, 731.25 lbs. Average gain, 200 lbs. Gain per cwt, 27.3 pounds. Value of food consumed for each pound gained, 4.47 cents.			

Pen 5—4 Steers.

Consumed per head in 90 days:			
3822.47 lbs. silage, at \$2 per ton	.....	\$3	82
496.4 " cotton meal, at \$20 per ton	.....	4	96
			<hr/>
			\$8 78
Average weight of steers, \$737.5 lbs. Average gain, 228.75 lbs. Gain per cwt, 31 lbs. Value of food consumed for each pound gained, 3.83 cents.			

Pen 6—3 Steers.

Consumed per head in 90 days.			
1387 lbs. silage, at \$2 per ton	.....	\$1	39
1306.9 lbs. cotton hulls at \$3 per ton	.....	1	96
531.5 lbs. cotton meal at \$20 per ton	.....	5	31
			<hr/>
			\$8 66
Average weight, 780 lbs. Average gain, 233.33 lbs. Gain per cwt, 29.9 lbs. Value of food consumed for each pound gained, 3.71 cents.			

Pen 7—4 Steers.

Consumed per head in 90 days:

1564 lbs. cotton hulls, at \$3 per ton.....	\$2 34
534 " cotton meal, at \$20 per ton.....	5 34
	<hr/>
	\$7 68

Average weight of steers, 713.75 lbs. Average gain, 206.25 lbs. Gain per cwt., 28.8 lbs. Value of food consumed for each pound gained, 3.72 cents.

Pen 8—4 Steers.

Consumed per head in 90 days:

1493 lbs cotton hulls, at \$3 per ton.....	\$2 22
366.85 lbs. cotton meal, at \$20 per ton.....	3 67
447.45 " corn and cob meal, at 40 cts. per bushel for the corn.....	2 56
	<hr/>
	\$8 45

Average weight of steers, 785.5 lbs. Average gain, 206.25 lbs. Gain per cwt., 23.6 lbs. Value of food consumed for each pound gained, 4.09 cents.

Pen 9—8 Steers.

Consumed per head in 90 days:

1245.25 lbs. cotton hulls, at \$3 per ton.....	\$1 89
532.12 " cotton meal, at \$20 per ton.....	5 32
568.26 " mixed hay, at \$6 per ton.....	1 69
	<hr/>
	\$8 90

Average weight of steers, 725.6 lbs. Average gain, 215 lbs. Gain per cwt., 29.7 lbs. Value of food consumed for each pound gained, 4.13 cents.

Pen 10—4 Steers.

Consumed per head in 90 days:

1677.7 lbs. cotton hulls, at \$3 per ton.....	\$2 51
530.5 " cotton meal, at \$20 per ton.....	5 31
5.57 gallons molasses, at 20 cts. per gallon.....	1 12
	<hr/>
	\$8 94

Average weight of steers, 727.5 lbs. Average gain, 238.75 lbs. Gain per cwt., 32.8 lbs. Value of food consumed for each pound gained, 3.73 cents.

Pen 11—3 Steers.

Consumed per head in 90 days:

1884.73 lbs. cotton hulls, at \$3 per ton.....	\$2 83
599.63 " cotton meal, at \$20 per ton.....	6 00
7.48 gallons molasses at 20 cts. per gallon.....	1 50
	<hr/>
	\$10 33

Average weight of steers, 868.33 lbs. Average gain, 251.6 lbs. Gain per cwt., 28.9 lbs. Value of food consumed for each pound gained, 4.1 cents.

SECOND LOT OF STEERS.

Pen 12—10 Steers.

Consumed per head in 79 days:

1758.7 lbs. silage, at \$2 per ton.....	\$1 76
1019.1 " cotton hulls, at \$3 per ton.....	1 53
430 " cotton meal, at \$20 per ton.....	4 30
	<hr/>
	\$7 59

Average weight of steers, 671 lbs. Average gain, 279 lbs. Gain per cwt., 41.5 lbs. Value of food consumed for each pound gained, 2.72 cents.

Pen 13—9 Steers.

Consumed per head in 79 days:

922.97 lbs. silage, at \$2 per ton	\$ 92
370.53 " hay, at \$6 per ton	1 11
485.8 " (6.07 bu.) corn in ear, at 40 cts.	2 42
430.56 " cotton seed, raw, at \$7 per ton	1 50

\$5 95

Average weight of steers, 662.8 lbs. Average gain, 232.2 lbs. Gain per cwt., 33.5 lbs.
 Value of food consumed for each pound gained, 2.67 cents.

Pen 14—3 Steers.

Consumed per head in 79 days:

591.53 lbs. hay, at \$6 per ton	\$1 77
1211 " (15.13 bu.) corn in ear, at 40 cts. per bushel	6 05
342.54 " cotton seed, cooked, at \$7 per ton	1 19

\$9 01

Average weight of steers, 636.6 lbs. Average gain, 233.3 lbs. Gain per cwt., 36.4 lbs.
 Value of food consumed for each pound gained, 3.86 cents.

COST OF FOOD.

The values given to the different feed-stuffs are fully one-fourth higher than actual cost the past year to cattle feeders and farmers, or at the oil mills in Texas. Throughout the corn belt of the State on the farms corn was worth less than 30 cents per bushel; hay on the farm not above \$4.50 per ton; cotton meal at the mills \$16, and hulls \$1.50 per ton and less. Having assumed the values given, with the first feeding experiment, it is thought best to retain the same to facilitate comparing one year's work with another. The values of feed and cost of one pound gained in weight may be easily calculated for any portion of the State.

TABLE NO. 1.

Average Amount of Food Consumed per Day for each Period of Ten Days.

	Pen No. 1—Six steers.				Pen No. 2—Four steers.			Pen No. 3—Six steers.		
	Corn fodder. Lbs.	Cooked cotton seed. Lbs.	Silage. Lbs.	Hay. Lbs.	Silage. Lbs.	Corn and cob meal. Lbs.	Cotton seed meal. Lbs.	Silage. Lbs.	Cooked cotton seed. Lbs.	Hay. Lbs.
December 28 to January 4.....	4.55	4.65	.....	.....	10.68	7.10	.....	15.38	3.29	.....
January 5 to January 14.....	6.51	6.75	.....	.....	9.51	8.51	0.1	25.24	5.67	.....
January 15 to January 24.....	5.96	9.95	.....	.....	13.68	7.94	2.0	29.29	9.08	.....
January 25 to February 3.....	5.24	9.62	.....	.....	20.99	7.89	2.0	22.07	9.09	.....
February 4 to February 13.....	6.62	9.28	.....	.....	23.94	8.0	2.0	21.71	9.2	.....
February 14 to February 23.....	.....	8.42	19.49	.....	29.43	.....	6.0	25.77	8.48	.....
February 24 to March 5.....	.....	6.95	18.61	.....	31.53	.....	6.32	22.93	7.55	.....
March 6 to March 15.....	.....	7.51	21.62	.....	38.66	.....	6.5	20.94	7.50	.....
March 16 to March 27.....	.....	7.94	19.88	2.29	33.07	.....	6.21	17.95	7.73	2.99
Total amount food consumed in 90 days.....	1678.1	4306.31	4956	164.9	8639	1521.1	1295.0	12,108.4	4110.15	215.4

TABLE NO. 2.

Average Amount of Food Consumed per Day for each Period of Ten Days.

	Pen No. 4—Four steers.			Pen No. 5—Four steers.		Pen No. 6—Three steers.		
	Silage. Lbs.	Cotton seed meal. Lbs.	Molasses. Pts.	Silage. Lbs.	Cotton seed meal. Lbs.	Hulls. Lbs.	Cotton seed meal. Lbs.	Silage. Lbs.
December 28 to January 4.....	21.4	4.43	0.5	19.04	2.53	13.21	3.77	13.41
January 5 to January 14.....	29.38	5.64	0.5	31.62	4.02	15.51	5.16	12.08
January 15 to January 24.....	36.18	5.82	0.5	40.71	5.73	16.19	5.91	13.43
January 25 to February 3.....	40.41	5.86	0.5	42.13	5.54	14.39	5.97	13.16
February 4 to February 13.....	36.52	6.00	0.5	41.61	5.99	14.41	6.00	14.06
February 14 to February 23.....	43.08	6.00	0.5	44.35	6.00	14.99	6.00	17.39
February 24 to March 5.....	39.41	5.88		41.95	6.32	13.56	6.43	17.03
March 6 to March 15.....	48.18	6.00		51.47	6.5	14.26	6.66	20.01
March 16 to March 27.....	41.52	6.00		40.14	6.21	14.01	6.66	16.81
Total food consumed in 90 days.....	13,606.4	2,030.2	116	14,290.9	1,985.6	3,920.8	1,593.6	4,161.20

TABLE NO. 3.

Average Amount of Food Consumed per Day for each Period of Ten Days.

	Pen No. 7—Four steers.		Pen No. 8—Four steers.			Pen No. 9—Eight steers.		
	Hulls. Lbs.	Cotton seed meal. Lbs.	Hulls. Lbs.	Cotton seed meal. Lbs.	Corn and cob meal. Lbs.	Hay. Lbs.	Hulls. Lbs.	Cotton seed meal. Lbs.
December 28 to January 4.....	14.01	4.31	15.11	2.75	4.31	6.21	10.45	4.22
January 5 to January 14.....	17.43	5.79	13.24	4.04	5.20	7.97	14.02	5.51
January 15 to January 24.....	18.39	5.96	16.17	4.27	5.54	5.27	15.59	6.00
January 25 to February 3.....	16.02	5.97	15.70	3.96	4.95	5.62	12.93	5.99
February 4 to February 13.....	17.57	6.00	17.73	4.00	5.00	5.69	14.57	6.00
February 14 to February 23.....	17.44	6.00	17.25	4.00	5.00	6.73	13.45	6.00
February 24 to March 5.....	17.74	6.32	17.52	4.32	5.00	6.37	14.55	6.32
March 6 to March 15.....	19.62	6.5	19.57	4.5	5.00	6.77	15.14	6.5
March 16 to March 27.....	17.89	6.21	15.89	4.48	4.67	6.17	15.33	6.25
Total amount of food consumed in 90 days....	6,276.00	2,138.00	5,932.09	1,467.04	1,789.08	4,546.01	10,162.0	4,267.00

TABLE NO. 4.

Average Amount of Food Consumed per Day for each Period of Ten Days.

	Pen No. 10—Four steers.			Pen No. 11—Three steers.		
	Hulls. Lbs.	Cotton seed meal. Lbs.	Molasses. Pts.	Hulls. Lbs.	Cotton seed meal. Lbs.	Molasses. Pts.
December 28 to January 4.....	11.84	3.85	0.48	19.12	5.19	0.64
January 5 to January 14.....	17.39	5.85	0.5	20.77	5.98	0.66
January 15 to January 24.....	18.29	5.94	0.5	23.59	6.60	0.66
January 25 to February 3.....	18.24	5.91	0.5	20.34	6.66	0.66
February 4 to February 13.....	19.97	6.0	0.5	22.35	6.66	0.66
February 14 to February 23.....	19.35	6.0	0.5	20.38	6.66	0.66
February 24 to March 5.....	20.03	6.32	0.5	19.90	7.1	0.66
March 6 to March 15.....	21.19	6.5	0.5	21.14	7.33	0.66
March 16 to March 27.....	19.35	6.21	0.5	20.50	7.33	0.66
Total amount of food consumed in 90 days.....	6710.8	2122.1	179.5	5654.2	1798.9	179.5

FEEDING EXPERIMENT.

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TABLE NO. 5.

Average Amount of Food Consumed per Day for each Period of Ten Days.

	Pen No. 12—Ten steers.			Pen No. 13—Nine steers.				Pen No. 14—Three steers.		
	Silage. Lbs.	Hulls. Lbs.	Cotton seed meal. Lbs.	Silage. Lbs.	Corn. Lbs.	Hay. Lbs.	Raw cotton seed. Lbs.	Corn. Lbs.	Hay. Lbs.	Cooked cotton seed. Lbs.
January 17 to January 24.....	13.21	8.09	3.05	3.58	4.58	3.71	2.45	15.79	7.32	.....
January 25 to February 3.....	15.23	11.21	4.14	4.67	6.73	4.22	4.44	22.96	18.07	.....
February 4 to February 13.....	17.45	12.93	4.91	7.35	6.93	4.62	4.93	16.74	6.21	.....
February 14 to February 23.....	21.22	11.88	4.98	13.36	6.21	3.83	5.25	12.91	5.99	3.68
February 24 to March 5.....	21.07	11.49	5.73	13.60	5.99	4.30	6.66	14.73	6.35	5.21
March 6 to March 15.....	24.68	13.21	5.45	14.57	5.99	5.94	6.23	13.74	6.54	5.95
March 16 to March 25.....	20.81	11.04	5.45	15.09	5.88	5.50	6.68	15.65	6.68	8.72
March 26 to April 5.....	24.4	12.36	5.45	18.52	6.5	6.2	6.54	10.8	7.5	8.65
Total amount of food consumed in 79 days.....	17,587.2	10,190.8	4302	8806.8	4372.1	3347.8	3875.1	3633.1	1774.6	1027.63

TABLE NO. 6.

Pen No. 1.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 28, 31.		January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.		Total gain.	Gain per day.		Ration changed.		Total gain, 110 days.
														April 5.	April 15.	Gain, 20 days.		
31.....	745	780	790	820	840	870	890	890	910	930	185	2.05	.....	.....	955	25	210
32.....	930	945	980	1000	960	995	1000	1000	1020	1020	90	1.11	1020	1020	.....	60	250
33.....	810	790	820	870	885	930	950	970	985	1000	190	2.11	.....	.....	1060	60	250
34.....	725	695	750	760	775	805	810	855	880	890	165	1.83	.....	.....	960	70	235
35.....	770	825	825	880	890	920	885	905	940	955	185	2.05	.....	.....	1010	55	240
36.....	780	785	800	840	845	840	865	890	900	935	155	1.72	.....	965	990	55	210
Average w't per head.	793.33	803.33	825	853.3	866	893.3	900	918.3	939	955	161.6	1.79	.....	.....	999.16	44.16	265.7
Gain per head per day between weighings.	.....	1	2.3	2.53	1.26	2.73	.66	1.83	2.06	1.6	.....	.....	.....	.....	2.20	.....	.....
Gain per head from beginning	.....	10	34.66	60	73.66	100	106.66	125	145.66	161.66	.....	.....	.....	.....	.....	.....	.....

TABLE NO. 7.

Pen No. 2.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 28, 31.		January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.		Total gain, 90 days.	Gain per day.		Ration changed.		Total gain, 110 days.
	Dec. 24, 28, 31.	Jan. 8.	Jan. 15.	Jan. 25.	Feb. 4.	Feb. 14.	Feb. 24.	Mar. 6.	Mar. 16.	Mar. 26, 27.	Mar. 26, 27.	Mar. 26, 27.	Apr. 5.	Apr. 15.	Apr. 25.	Apr. 5.	Apr. 15.	Apr. 25.
5.....	730	730	735	780	785	830	840	890	890	900	170	1.88	965	985	85	255	.....	255
6.....	645	640	620	690	690	715	750	765	795	820	175	1.94	830	870	50	225	.....	225
7.....	650	670	665	710	690	735	730	790	765	770	120	1.33	805	805	35	155	.....	155
8.....	745	780	800	830	860	885	880	900	965	935	190	2.12	.....	980	45	235	.....	235
Average weight per head.....	692.5	705	705	752.05	751.25	798.75	800	826.25	853.75	856.25	163.75	1.82	.....	910	53.5	217.5	.....	217.5
Gain per head per day between weighings.....	.....	1.25	.....	4.75	-0.12	4.25	.72	2.62	2.75	.27	.....	.....	.....	2.18	.....	.....	.....	.....
Gain per head from beginning.....	.....	13.5	13.5	60	58.75	101.25	107.5	123.75	161.25	163.75	.....	.....	.....	.....	.....	.....	.....	.....

TABLE NO. 8.
Pen No. 3.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.	January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.	Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
													April 5.	April 15.	Gain, 20 days.	
37.....	770	775	795	845	860	890	920	930	950	925	155	1.72	990	1000	75	320
38.....	800	820	840	885	860	900	915	930	935	935	135	1.5	940	1000	65	200
39.....	890	860	870	950	950	975	1000	1025	1025	1020	190	2.11	1050	1055	35	225
40.....	725	800	800	840	830	850	885	890	880	880	155	1.72	900	905	25	180
41.....	710	705	755	825	815	840	835	870	890	860	150	1.66	850	895	35	185
42.....	700	715	760	795	795	835	815	850	860	900	200	2.22	.....	955	55	255
Average weight per head.....	755.8	779	802.3	858.3	851.6	886.6	895	915	925	920	164.1	1.82	.....	968.33	48.33	212.4
Gain per head per day between weighings.....	.....	2.3	3.33	5.6	.66	3.6	.83	2	1	.5	.....	.....	.....	2.41	.....	.....
Gain per head from beginning.....	.....	23.2	46.5	102.5	95.8	130.8	139.2	159.2	169.2	164.1	.....	.....	.....	.....	.....	.....

TABLE NO. 9.
Pen No. 4.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.	January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.	Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
													April 5.	April 15.	Gain, 20 days.	
1.....	780	820	845	875	860	890	900	910	915	920	140	1.55	940	965	45	185
2.....	800	860	910	950	975	1000	1045	1045	1045	1085	235	3.16	1100	1090	5	290
3.....	635	660	645	685	710	760	790	780	790	815	180	2.15	885	885	20	200
4.....	710	740	760	820	805	835	865	885	880	905	185	2.15	930	950	45	240
Average wt. per head....	731.25	770	790	832.25	837.5	871.25	892.5	905	905	931.25	200	2.22	.....	960	28.75	228.75
Gain per head per day between weighings.....	.....	3.37	2.85	4.22	.52	3.37	2.12	1.25	.....	3.12	.....	.....	.....	1.37	.....	.....
Gain per head from beginning.....	.....	38.75	58.75	101	106.25	140	161.25	173.75	173.75	200	.....	.....	.....	.....	.....	.....

TABLE NO. 10.
Pen No. 5.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.	January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.	Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
													April 5.	April 15.	Gain, 20 days.	
9.....	695	715	755	820	820	850	890	895	915	910	225	2.5	935	945	35	260
10.....	725	765	790	835	895	895	900	905	950	930	205	2.28	.....	974	45	250
11.....	725	735	770	795	820	830	890	895	930	925	200	2.22	960	965	40	240
12.....	815	900	950	960	990	1060	1040	1100	1100	1100	285	3.16	1110	1120	20	305
Average w't per head....	737.5	778.75	816.25	852.5	881.25	908.75	930	948.75	973.75	966.25	228.75	2.64	.....	1001.25	36	263.75
Gain per head per day between weighings.....	.....	4.12	5.85	3.62	2.87	2.75	2.12	1.87	2.5	.75	.....	.....	.....	1.76	.....	.....
Gain per head from beginning.....	.....	41.25	78.75	115	143.75	171.25	192.5	211.25	236.25	228.75	.....	.....	.....	.....	.....	.....

TABLE NO. 11.
Pen No. 6.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.		January 8.		January 15.		January 25.		February 4.		February 14.		February 24.		March 6.		March 16.		Average of weights, March 26, 27.		Total gain, 90 days.		Gain per day.		Ration changed.				Total gain, 110 days.	
																								April 5.	April 20.	Gain, 20 days.				
25.....	760	825	850		890	895		915	950	955	1000		985		225	2.5	1010	1005	20	245										
26.....	760	840	845		880	890		930	920	955	995		980		220	2.44	1050	1055	75	235										
27.....	820	870	885		935	960		995	1025	1070	1080		1075		255	2.83	1110	1110	35	290										
Average weight per head....	780	845	860	901.66	915	946.66		965	993.33	1025	1013.33		233.33	2.59	.....	.....	1056.6	43.33	276.6										
Gain per head per day be- tween weighings.....	6.5	2.14	4.17	1.32	3.17	1.82		2.82	3.17	1.17	.....	.....	.....	.....	.....	.....	2.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gain per head from begin- ning.....	65	80	121.66	135	166.66	185	213.33	245	233.33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE NO. 12.
Pen No. 7.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.		January 8.	January 15.	January -5.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.		Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
														April 6.	April 15.	Gain, 20 days.		
18.....	730	800	765	785	810	840	865	890	910	910	910	180	2	960	985	75	255	
21.....	725	775	795	815	805	840	845	870	885	910	185	2.05	915	950	40	225		
22.....	680	720	740	780	790	830	845	870	885	900	220	2.46	940	925	25	245		
24.....	720	750	795	815	845	869	885	930	950	960	240	2.66	980	1005	45	295		
Average weight per head.....	713.75	761.25	773.75	798.75	812.5	844.75	860	890	907.5	920	206.25	2.29	.....	.....	966.25	46.25	252.50
Gain per head per day between weighing.....	.....	4.75	1.78	2.5	1.32	3.22	1.52	3	1.75	1.25	.....	.....	.....	.....	2.31	.....	.....
Gain per head from beginning.....	.....	47.5	60	85	98.25	131	146.25	176.25	183.25	206.25	.....	.....	.....	.....	.....	.....	.....

TABLE NO. 13.
Pen No. 8.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.		January 8.		January 15.		January 25.		February 4.		February 14.		February 24.		March 6.		March 16.		Average of weights, March 26, 27.		Total gain, 90 days.		Gain per day.		Ration changed.				Total gain, 110 days.			
																									April 5.		April 15.		Gain, 20 days.			
13.....	835	885	885	935	925	1000	990	1010	1030	1015	180	2	1045	1090	75	255																
14.....	835	865	900	915	920	975	985	1000	1030	1010	175	1.94	1040	1030	20	195																
15.....	725	780	815	845	845	890	910	925	950	920	195	2.16	960	985	65	260																
16.....	735	800	850	870	870	910	950	975	1010	1010	275	3.05	1025	1015	5	280																
Average weight per head.	782.5	832.5	862.5	891.25	895	943.75	968.75	977.5	1005	988.75	506.25	2.29	1030	41.25	247.5															
Gain per head per day be- tween weighings.....	5	4.28	2.87	.37	4.87	1.06	1.87	2.75	-1.62	2.06															
Gain per head from be- ginning.....	50	80	108.75	112.5	161.25	176.25	195	222.5	206.25															

TABLE NO. 14.
Pen No. 9.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.	January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.	Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
													April 6.	April 20.	Gain, 20 days.	
43	685	710	725	750	760	785	810	835	855	855	170	1.88	895	910	55	225
44	665	710	735	780	790	815	830	840	850	855	190	2.11	890	905	50	240
45	735	760	790	840	840	875	890	920	950	955	220	2.44	960	980	25	245
46	780	840	850	905	920	960	990	1000	1030	1035	255	2.83	1070	1075	40	295
47	685	740	755	785	845	860	890	910	930	925	240	2.66	950	935	10	250
48	760	785	815	855	850	870	915	930	930	930	170	1.88	960	975	45	215
49	780	850	855	900	920	950	990	1025	1035	1045	265	2.94	1045	1060	15	280
50	715	745	785	820	820	880	890	910	915	925	210	2.33	920	960	35	245
Average weight per head.....	725.6	766.25	788.75	829.37	843.12	873	895	919.37	937	940.6	215	2.38	.....	975	34.37	249.3
Gain per head bet. weighings.....	.....	4.42	3.21	4.16	1.37	2.98	2.2	2.43	1.75	.36	.....	.....	.....	1.71	.....	.....
Gain per head from beginning .....	.....	40.65	63.15	103.77	117.52	147.3	169.3	193.77	211.3	215	.....	.....	.....	.....	.....	.....

TABLE NO. 15.
Pen No. 10.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.	January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.	Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
													April 5.	April 15.	Gain, 20 days.	
17.....	775	890	900	940	950	1000	1010	1050	1070	1050	275	3.05	1050	1070	20	295
19.....	700	750	785	800	805	860	875	885	900	895	195	2.16	920	940	45	240
20.....	700	735	740	780	790	840	850	875	900	915	215	2.38	920	935	20	235
23.....	735	740	825	860	870	915	935	965	995	1005	270	3.00	1015	1065	60	330
Average wt. per head...	727.5	776.25	812.5	842.5	853.75	903.75	917.5	943.75	966.25	966.25	238.75	2.65	.....	1002.5	36.25	275
Gain per head per day between weighings.....	.....	4.87	5.17	3	1.12	5	1.37	2.62	2.25	.....	.....	.....	.....	1.81	.....	.....
Gain per head from beginning.....	.....	48.75	85	115	126.25	176.25	190	216.25	238.75	238.75	.....	.....	.....	.....	.....	.....

TABLE NO. 16.
Pen No. 11.—Live Weights.

No. of steer.	Average of weights, Dec. 24, 25, 31.	January 8.	January 15.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	Average of weights, March 26, 27.	Total gain, 90 days.	Gain per day.	Ration changed.			Total gain, 110 days.
													April 5.	April 15.	Gain, 20 days.	
28	1090	1110	1150	1205	1235	1280	1285	1335	1345	1345	325	3.61	1400	1360	15	340
29	915	1020	1050	1075	1085	1115	1100	1125	1155	1160	245	2.72	1200	1210	50	295
30	670	730	730	780	785	800	825	830	860	855	185	2.05	875	885	30	215
Average weight per head.....	868.33	953.33	976.66	1033.33	1035	1065	1070	1096.66	1120	1120	251.6	2.79	.....	1151.66	31.66	283.3
Gain per head per day bet'n wgs.....	.....	8.5	3.33	5.66	.16	3	5	2.66	2.33	.....	.....	.....	.....	1.58	.....	.....
Gain per head from beginning.....	.....	85	108.33	165	166.66	196.66	201.66	228.33	251.66	251.66	.....	.....	.....	.....	.....	.....

TABLE NO. 17.
Pen No. 12.—Live Weights.

No. of steer.	Average of weights, Jan. 16, 21.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	March 26.	Average of weights, April 6, 6.	Total gain, 79 days.	Gain per day.	Ration changed.		
												April 15.	Gain, 10 days.	Total gain, 89 days.
52.....	620	660	720	765	745	815	860	870	870	250	3.16	930	60	310
53.....	650	665	760	770	815	870	865	900	920	270	3.41	940	20	290
54.....	595	640	710	740	740	800	835	845	870	275	3.48	890	20	295
55.....	665	715	760	810	860	900	915	955	975	310	3.91	990	15	325
56.....	600	660	700	735	770	825	840	870	900	300	3.78	900	.....	300
57.....	635	675	750	780	810	850	870	880	910	275	3.48	950	40	315
58.....	680	690	700	750	795	835	835	870	885	285	3.6	900	15	300
59.....	950	1020	1050	1085	1100	1170	1200	1235	1255	255	3.6	1270	35	320
60.....	705	740	790	850	875	935	940	980	1000	295	3.73	.....	.....	.....
61.....	690	700	755	790	820	875	890	905	935	245	3.1	1005	70	315
Average weight per head.....	671	713.5	769.5	807.5	833	886.5	905	941	950	279	3.53	975	30.55	307.77
Gain per head per day between weighings.....	.....	5.43	5.6	3.8	2.65	5.35	1.75	3.6	.95	.....	.....	.....	.....	.....
Gain per head from beginning.....	.....	62.5	98.5	136.5	162	216.5	234	270	279	.....	.....	.....	.....	.....

TABLE NO. 18.
Pen No. 13.—Live Weights.

No. of steer.	Average of weights, Jan. 16, 21.	January 25.	February 4.	February 14.	February 24.	March 6.	March 16.	March 26.	Average of weights, April 5, 6.	Total gain, 79 days.	Gain per day.	Ration changed.		
												April 15.	Gain, 10 days.	Total gain, 89 days.
62.....	725	735	780	810	840	865	865	885	920	195	2.46	1000	80	275
63.....	675	690	730	810	865	890	920	960	970	295	3.73	.....	.....	.....
64.....	720	745	750	810	860	870	885	905	915	195	2.46	960	45	240
65.....	660	600	590	635	670	720	750	790	785	125	1.58	840	55	180
66.....	830	845	850	885	970	1030	1065	1110	1120	290	3.68	1180	60	350
67.....	670	705	740	790	790	860	880	905	900	230	2.91	945	45	275
68.....	570	575	585	640	665	700	710	755	775	205	2.59	795	20	225
69.....	560	620	635	690	760	790	825	875	875	315	3.98	950	75	390
70.....	555	575	665	695	635	660	700	715	705	150	1.89	740	35	185
Average weight per head.....	662.8	676.6	702.7	751.7	784	820.5	844.4	877.7	885	222.2	2.81	926.25	51.87	265
Gain per head per day bet. weighings.....	.....	1.72	2.61	4.9	3.23	3.65	2.39	3.33	.73	.....	.....	5.18	.....	.....
Gain per head from beginning.....	.....	13.8	39.9	88.9	121.2	157.7	181.6	204.9	222.2	.....	.....	.....	.....	.....

TABLE NO. 19.
Pen No. 14.—Live Weights.

No. of steer.	Average of weights, Jan. 16, 21.	January 25.	February 4.	February 14.	February 19.	February 24.	March 6.	March 16.	March 26.	Average of weights, April 5, 6.	Total gain.	Gain per day.	Ration changed.		
													April 15.	Gain, 10 days.	Total gain, 89 days.
73.....	655	690	680	745	760	795	865	880	920	930	275	3.48	970	40	315
74.....	595	625	645	670	710	730	765	800	830	835	240	3.03	890	55	295
75.....	660	650	695	625	655	690	750	790	835	845	185	2.34	885	40	225
Average weight per head.....	636.6	655	673.3	690	708.3	738.3	793.3	823.3	861.6	870	233.3	2.95	915	45	278.3
Gain per head per day bet. weighings.....	.....	2.28	1.83	.66	5.66	6	5.6	3	3.38	1.03	.....	.....	4.6	.....	.....
Gain per head from beginning.....	.....	18.3	36.6	43.3	71.7	101.7	166.7	186.7	223	233.3	.....	.....	.....	.....	.....

TABLE NO. 20.
SUMMARY NO. 1.
First Lot of Cattle.

No. of Pen.	Average weight of steers, Lbs.	Average gain per head, Lbs.	Gain per cwt. Lbs.	Gain per day. Lbs.	Cost of food per lb. gain.	Cost of food per head.	Ration fed—90 Days.	Ration changed steers fed 20 days.		
								Average gain, 20 days.	Total gain, 110 days.	Gain per day.
1	7933.3	161.6	21.0	1.79	2.55	4.12	Silage, corn fodder, hay, boiled cotton seed	44.1	205.7	2.20
2	692.5	163.7	23.9	1.82	4.6	7.55	Silage, corn and cob meal; cotton meal part of the time.....	53.5	217.5	2.1
3	755.8	164.1	21.8	1.82	2.8	4.59	Silage, hay, boiled cotton seed.....	48.3	212.4	2.4
4	731.2	200.0	27.3	2.22	4.47	9.20	Silage, cotton meal, molasses.....	28.7	228.7	1.3
5	737.5	228.7	31.0	2.54	3.53	8.78	Silage, cotton meal.....	35	263.7	1.7
6	780.0	233.3	29.9	2.59	3.71	8.66	Silage, cotton hulls, cotton meal.....	43.3	276.6	2.1
7	713.7	206.2	28.8	2.29	3.72	7.68	Cotton hulls, cotton meal.....	46.2	252.5	2.3
8	875.5	206.2	23.5	2.29	4.09	8.45	Cotton hulls, cotton meal, corn and cob meal.....	41.2	247.5	2.0
9	725.6	215.0	29.7	2.38	4.13	8.90	Cotton hulls, cotton meal, mixed hay.....	34.3	249.3	1.7
10	727.5	238.7	32.8	2.65	3.73	8.94	Cotton hulls, cotton meal, molasses.....	36.2	275.0	1.8
11	868.3	251.6	28.9	2.79	4.1	10.33	Cotton hulls, cotton meal, molasses.....	31.6	283.3	1.5

* Pen 6 is repeated to include it with the cotton hull fed pens.

Second Lot of Cattle.

No. of Pen.	Average weight of steers, Lbs.	Average gain per head, Lbs.	Gain per cwt. Lbs.	Gain per day. Lbs.	Cost of food per lb. gain.	Cost of food per head.	Ration fed—79 Days.	Ration changed steers fed 10 days.		
								Average gain, 10 days.	Total gain, 89 days.	Gain per day.
12	671.0	279.0	41.5	2.53	2.72	7.59	Silage, cotton hulls, cotton meal.....	30.5	315	3.0
13	662.8	222.2	32.5	2.51	3.1	7.00	Silage, hay, corn in ear, raw cotton seed.....	51.8	265	5.18
14	636.6	233.3	36.4	2.95	3.86	11.61	Hay, corn in ear, boiled cotton seed last 7 weeks.....	45.0	278.3	4.5

TABLE NO. 21.
SUMMARY NO. 2.

First Lot of Cattle.—Average Gain in Weight from Beginning to Date.

No. of pen.	Av. weight at beginning, Dec. 23. Lbs.	Ration fed—90 Days.									
		January 8. Lbs.	January 15. Lbs.	January 25. Lbs.	February 4. Lbs.	February 14. Lbs.	February 24. Lbs.	March 6. Lbs.	March 16. Lbs.	March 27. Lbs.	
1	793.3	10.0	34.6	60.0	73.6	100.0	106.6	125.0	145.6	161.6	Silage, corn fodder, hay, boiled cotton seed.
2	692.5	13.5	13.5	60.0	58.7	101.2	107.5	123.7	161.3	163.7	Silage, corn and cob meal, cotton meal.
3	755.8	23.2	46.5	102.5	95.8	130.8	139.2	159.2	169.2	164.1	Silage, hay, boiled cotton seed.
4	731.2	38.7	58.7	101.0	106.2	140.0	161.2	173.7	173.7	200.0	Silage, cotton meal, molasses.
5	737.5	41.2	78.7	115.0	143.7	171.2	192.5	211.2	236.2	228.7	Silage, cotton meal.
6	780.0	65.0	80.0	121.6	135.0	166.6	185.0	213.3	245.0	233.3	Silage, cotton meal, cotton hulls.
7	713.7	47.5	60.0	85.0	98.2	131.0	146.2	176.2	183.2	206.2	Cotton hulls, cotton meal.
8	875.5	50.0	30.0	103.7	112.5	161.2	176.2	195.0	222.5	206.2	Cotton hulls, cotton meal, corn and cob meal.
9	725.6	40.6	63.1	103.7	117.5	147.3	169.3	193.7	211.3	215.0	Cotton hulls, cotton meal, mixed hay.
10	727.5	48.7	85.0	115.0	126.2	176.2	190.0	216.2	238.7	238.7	Cotton hulls, cotton meal, molasses.
11	868.3	85.0	108.3	165.0	166.6	186.6	201.6	228.3	251.6	251.6	Cotton hulls, cotton meal, molasses.

Second Lot of Cattle.

No. of pen.	Average weight Jan. 17. Lbs.	Jan. 26. Lbs.	Feb. 4. Lbs.	Feb. 14. Lbs.	Feb. 24. Lbs.	March 6. Lbs.	March 16. Lbs.	March 26. Lbs.	April 5. Lbs.	Ration fed—79 Days.
12	671.0	62.5	98.5	136.5	162.0	216.5	234.0	270.0	279.0	Silage, cotton hulls, cotton meal.
13	662.8	15.8	39.9	88.9	121.2	157.7	181.6	204.9	222.2	Silage, hay, corn in ear, raw cotton seed.
14	636.6	18.3	36.6	43.3	101.7	156.7	186.7	233.3	.....	Hay, corn in ear, boiled cotton seed last seven weeks.

COTTON SEED HULLS AND SILAGE.

Estimating the annual cotton crop of the State for the next decade at 1,750,000 bales, there would be produced some 875,000 tons of cotton seed. If one-half of the seed crop is converted into oil, meal, and hulls at the oil mills, there will be something like 200,000 tons of hulls as the yearly output, which, with cotton meal and other concentrated feed-stuffs, will fatten, as shown by our experiments and results obtained from feeding at the oil mills, 200,000 head of cattle.

The use of all the hulls at the mills for feeding will increase the value of cotton seed and supply a home market for range cattle not in a condition to be slaughtered, and thus benefit both cotton planter and cattle grower.

SILAGE

is used to but a limited extent as yet in the State for feeding cattle, but it has been tested sufficiently to have passed the experimental stage. More than 10,000 farmers, dairymen, and cattle feeders in the country have decided that silage is one of the cheapest and best cattle foods they can procure.

Silage is similar to hay, except that in place of drying a forage crop by exposure to the sun and air after cutting, the crop is stored at once in a tight room in the green state; and when fed out it still retains its succulent condition, and is therefore eaten cleaner and with more relish by stock than dry fodder.

The ensilage process enables the farmer to utilize coarse and rank growing crops, such as corn and sorghum, which are cured as hay in the dry way with difficulty, and with considerable uncertainty and loss. Even at the best, if a heavy crop is grown, the stalks are coarse and woody, and are rejected by the cattle. But no matter how heavy the crop of corn and sorghum, if it is passed through the feed cutter and packed in the silo before becoming fully ripe, the stalks and ears are softened, and the entire plant is consumed without loss, if fed with care.

Land that will produce 30 to 35 bushels of corn to the acre will make 15 tons of silage from either corn or sorghum. Sorghum thrives in any place in Texas where any farm crop will grow, and on the light soils and in dry years it yields more to the acre than corn; 20 to 25 tons is not an unusual yield on the best lands. Estimating man and horse labor at \$1 per day each, the crop for silage, either corn or sorghum, may be grown, cut down, run through the

cutter, and stored in the silo ready to feed at a total cost of less than \$1.50 per ton.*

COST OF SILO AND MACHINERY.

A 200-ton double silo, each room 18x18x20 feet deep, built after the model of the Station silos, will require some 12,000 feet of lumber, 10,000 shingles, 350 square yards of tarred paper, and 650 pounds of nails, spikes, and bolts; and any man who can use a saw, square, and hammer can build it. A silo, however, can be built on a cheaper plan that will answer every purpose. A 200-ton silo will hold sufficient silage to feed 100 steers for more than 100 days.

The cost of feed cutter and horse power, with capacity for cutting up 20 tons of corn or sorghum forage per day is not above \$175 laid down at any railway station in the State, and with careful handling the outfit would last ten years.

The larger the silo the less the cost of building in proportion to capacity. The silo is not adapted to the needs of the small farmer, as the cost of building and machinery is too large an investment to be supported by a few cattle. The dairyman with 20 or more cows, and the farmer who fattens 30 to 50 steers, will find it profitable; while the extensive cattle feeder will find it almost indispensable to reduce the cost of feeding to the minimum.

For the reasons set forth we have paid especial attention to silage and cotton hulls in our feeding experiments, and from the foregoing it will be observed that we have in cotton hulls; for cattle feeders in the vicinity of oil mills, cheap rough fodder for feeding a large number of cattle; and by growing silage we can produce cheap feed in almost any part of the State, and in unlimited quantity, which in addition to our corn, hay, and other forage crops should enable us to fatten all cattle before they are slaughtered or leave the State.

FEEDING MOLASSES.

In looking over the different rations fed to different pens of steers it will be noticed that we have included molasses in three of the pens. It was thought that a little sweetening added to cotton hulls and meal might make the food more palatable, and thus induce the cattle to eat more and gain faster. The molasses was diluted with three parts water to one of molasses, and sprinkled over the food at the rate of one-half pint of molasses per head per day.

Pens 10 and 11, fed cotton hulls and cotton meal with the molasses, ate 18.64 and 20.94 pounds of hulls per head per day; while pen 7, fed cotton hulls and cotton meal, and pen 8, cotton hulls, cotton meal, and corn and cob meal, ate 17.29 and 16.58 pounds hulls per head per day, showing a greater consumption of hulls with molasses.

*John Gould, of New York State, who has had considerable experience in growing silage crops, figures the cost of corn silage per acre as follows in a recent letter to the American Dairyman:

For the use of an acre of land.....	\$ 1 80
Plowing and planting.....	2 25
Rye sowed the fall before and plowed under for manure, 2 bushels	90
Seed corn.....	25
Taxes on land.....	27
Cultivation of crop.....	1 25
Cutting, hauling, and running through cutter into silo.....	7 50

\$14 22

Yield, 17 loads of 2400 pounds, or 20.4 tons, at a cost of 70 cents per ton, which would make the cost of a 50-pound ration per day 1½ cents. From this we see that an acre of fairly good land will supply the rough forage to feed one steer 500 days and over.

Pens 10 and 11 made the largest gains in weight of any of the lot of fifty Williamson County steers—237.7 pounds and 251.6 pounds per head; and the cost of food per pound gain for pen 10 is as low as any of the cotton meal and corn meal fed cattle, while in pen 11 it is a little higher, but still under the cost in four other pens of the lot.

The same quantity of molasses per head was fed to pen 4 with silage and cotton meal for 58 days. Comparing increase in weight of pen 4 with that of pen 5, fed silage and cotton meal alone (Summary 1, Table 20, and Tables 11 and 12), we notice that pen 4 made average gain of 200 pounds, while pen 5 made 228.7 pounds, a loss of 28.7 pounds per head from feeding molasses.

The two pens were nearly of the same average weight. Pen 4 consumed 37.99 pounds of silage and 5.63 pounds cotton meal with the molasses, and pen 5 consumed 39.69 pounds of silage and 5.55 cotton meal per head per day—a little more silage, but not quite so much cotton meal—not sufficient difference in the amount of food consumed by each pen to account for the difference in increase in weight, unless it is held that the molasses lowered the nutritive value of the ration.

The figures in Tables 9 and 10, pens, 4 and 5, may account for the lesser gain made by the molasses fed steers. Steer No. 1, pen 4, was a wild, raw-boned animal, and gained but 140 pounds, while the average gain of the three other steers in the pen was 220 pounds.

In pen 5, the lowest gain made was 200 pounds, and the average gain of the pen 228 pounds. If steer No. 1 had been as good a feeder as other steers in his pen, pen 4 would compare more favorably with pen 5.

We are inclined to believe that molasses does not improve a ration made up largely of silage, and that it may be injurious to some slight extent. The feed left uneaten soured at once, and the manger had a sour smell while the molasses was used, which was not the case with the hulls, meal and molasses ration. We are led to conclude that cheap molasses may be profitably added to cotton hulls and meal, but not to silage, which is already sweet or has an acid flavor which makes it palatable to the animal.

SILAGE V. DRY CORN FODDER.

Pen 1 was fed dry corn forage with boiled cotton seed to February 14, forty-eight days. Silage was then substituted for corn. The average gain of the pen to February 14, was 100 pounds. See Summary 2, Table 21.

Pen 3 was fed silage and boiled cotton seed during the same time, and the average gain was 130.8 pounds.

Pen 1 steers had some advantage in weight, averaging 37 pounds heavier than pen 3 at the beginning.

The corn fodder was the same as the silage corn, except that when cut in the field it was shocked, allowed to cure, and then hauled in and stored in the loft in the barn without loss of leaves or ears. The silage corn was cut in the field, hauled at once to the cutter, and run into the silo. The forage was fed whole, the cattle eating the ears, shucks, and leaves, but refusing the stalks. Of the corn forage placed in the mangers, 47 per cent was consumed by the cattle, and 53 per cent refused. Yet this corn was cured and stored under the best conditions, much better than could be expected on the average farm with a large crop; 8.2 per cent of the silage fed to pen 3 during the same time was rejected, and 91.8 per cent consumed.

The steers in the different pens were fed in the same way, twice a day, morning and night. The troughs were swept out clean each time before feeding, and if any of the last feed remained, it was carefully weighed, and

if much remained, the quantity of the next meal was decreased. When the steers cleaned out the troughs and seemed inclined to eat more, the quantity was increased at the next meal.

Pen 1 consumed more cotton meal than pen 3. The steers in the two pens were quite uniform, and gains in weight made in each pen did not vary widely, except with steer No. 32, pen 1. This steer gained but 90 pounds in the 90 days feeding, while the next lowest gain was 135 pounds. Steer No. 32, however, was a round, smooth steer, in the highest flesh of any in entire lot of 50 at the beginning, and a light eater, so that while he gained less than the average, he consumed less also.

COTTON SEED V. COTTON MEAL.

Summary 1, Table 20, first lot of cattle, shows that cotton seed in pens 1 and 3 made increase in weight of steers at considerable less cost per pound than the cotton meal in all the other pens of the first lot of steers.

Pens 1 and 3, fed cotton seed; value of food for 1 pound gain, 2.55 to 2.8 cents.

Pens 2, and 4 to 11, fed cotton meal; value of food 3.71 to 4.6 cents for 1 pound gain.

In the experiment of the previous winter:

Pens 3 and 4 fed, cotton seed; value of food per pound gain, 2.85 to 2.86 cents.

Pens 2, 6 and 7, fed cotton meal; value of food per pound gain, 3.63 to 4.47 cents.

The total gain in weight, however, is in favor of the cotton meal fed steers.

Pens 1 and 3, 1890, gained 161 and 164 pounds in 90 days.

Pens 4 to 11, 1890, gained from 200 to 251 pounds in 90 days.

In 1889 the largest gains were also made by the cotton meal fed steers.

Our two experiments seem to show quite conclusively that cotton seed at \$7 per ton is a much cheaper feed-stuff than cotton meal at \$20, if calculated on cost of food per pound gain made by steers; but, on the other hand, steers fed on cotton meal gain so much more when fed 80 to 90 days, that the extra cost is partly made up in increased value of the steers due to better condition.

SILAGE AND CORN.

Pen 2 was fed silage, corn, and cob meal, to compare with silage and cotton seed, and silage and cotton meal.

Judged from a chemical analysis of the silage and corn ration, according to the German standards, it would not be equal to silage and cotton seed or cotton seed meal.

Silage and corn cob meal were fed for fifteen days. The steers ate less than half as much silage as pens 3, 4, and 5, that were getting silage, cotton seed, and cotton meal.

Two pounds of cotton meal were then added until February 14, 48 days. The average gain in weight to this date was 102 pounds, but two pounds more than the gain made on dry corn fodder and cotton seed in pen 1; while the gain in all of the other pens ran above 130 pounds. See Summary 2, Table 21.

Six pounds of cotton meal was then substituted for the grain part of the ration, and better results were secured.

COTTON SEED ADDED TO CORN AND HAY.

Pen 14, second lot of steers, was fed hay and corn 30 days (see Tables 7 and 21), and steers gained 43.3 pounds—1.44 pounds per day each. In the same time the steers of pen 12, fed silage, cotton hulls, and cotton meal, gained 136.5 pounds; and steers in pen 13, fed silage, hay, corn, and raw cotton seed, gained 88.9. Boiled cotton seed was then added to the corn and hay, starting with $3\frac{1}{2}$ pounds and increasing to nearly 9 pounds per day of dry seed. After adding cotton seed, the steers made an average gain of 3.22 pounds per day, more than either pens 12 or 13.

The steers of pen 14 were not dehorned, nor fed under shelter, as were the other steers; but this would not have any special influence on the change in the ration.

HAY AND CORN V. SILAGE, COTTON HULLS, COTTON SEED, AND COTTON MEAL.

The cattle in pen 14, fed hay and corn, gained 43.3 pounds in 30 days, while the steers in pens 12 and 13, fed on silage and hulls, cotton seed, and cotton meal, gained 136.5 pounds, and 88.9 pounds of the second lot of steers. In the first lot of steers two pens gained 60 pounds, one pen gained 85 pounds, and the remaining eight pens 102 pounds and over.

In our first feeding experiment, 1889, six steers in each pen:

Pen 8, fed hay and corn under shed 83 days, gained 173 pounds.

Pen 9, fed hay and corn in open lot 83 days, gained 158 pounds.

Pen 2, fed silage, hay, and cotton meal under shelter 83 days, gained 170 pounds.

Pen 3, fed silage hay, and boiled cotton seed under shelter 83 days, gained 173 pounds.

Pen 5, fed silage, hay, corn and cob meal, and cotton meal 83 days, gained 197 pounds.

Pen 6, fed cotton hulls and cotton meal under shelter 83 days, gained 202 pounds.

Pen 7, fed silage, hay, and cotton meal under shelter 83 days, gained 178 pounds.

Comparing the gain in weight of pens of steers fed hay and corn under shelter with steers of pens fed silage, cotton hulls, and cotton meal rations, it will be noticed that one is 3 pounds less, one the same, while three are above the gain made from corn and hay.

The results of the two years' feeding experiments bear strong evidence as to the superior feeding qualities of cotton seed products and silage over corn and hay for cattle.

EFFECT OF VARYING THE RATION.

With the exception of pens 1, 2, 4, and 14, no change was made in the feed-stuffs from which the rations were compounded in the first lot of steers for 90 days, and in the second lot for 79 days. In pens 1, 2, 4, and 14 the change made consisted simply in dropping and adding a single substance.

Summary 3, Table 22, shows that in nearly all of the pens the largest gains in weight per day was made during the first 50 days' feeding, and that after that time the gains per day decreased gradually to the last ten days before the ration was changed, after which the gain per day increased with all the pens, except No. 4.

After the cattle were turned together they were fed silage, cotton hulls,

hay, corn, boiled cotton seed, and cotton meal. The exact amount of food consumed was not kept.

The importance of varying the ration after cattle have been fed some time is shown in the gain made after changing the ration:

	Pounds.
The average daily gain of the first lot of 50 steers for 90 days.....	2.5
From the 80th to the 90th day.....	3.7
From the 90th to the 110th day, with change of food.....	1.9
The average daily gain of the second lot of cattle for 79 days.....	3.09
From the 69th to the 79th day.....	.7
From the 79th to the 89th day.....	4.22

Summary 3, Table 22, gives the daily gain of each pen for each ten days, and the average gain of all the pens divided into groups. In pens 1, 2, 4 and 14 the ration was changed during the first period, but in the other pens it was the same for 90 days with the first lot of cattle, and 79 days with the second lot of cattle. See Tables 1, 2, 3, 4, and 5.

TABLE NO. 22.

SUMMARY NO. 3.

Gain in Weight per Head per Day for Each Period of Ten Days.

No. of pen.	Average weight of steers.	First 10 days.	Second 10 days.	Third 10 days.	Fourth 10 days.	Fifth 10 days.	Sixth 10 days.	Seventh 10 days.	Eighth 10 days.	Ninth 10 days.	*Tenth and eleventh 10 days.
1.....	793.3	1.0	2.3	2.53	1.26	2.73	.66	1.83	2.06	1.6	2.20
2.....	692.5	1.25	.....	4.75	-.12	4.25	.72	2.62	2.75	.27	2.18
4.....	731.2	3.87	2.85	4.22	.52	3.37	2.12	1.25	.....	3.12	1.87
Average for the 3 pens.....	.....	2.04	1.71	3.83	.52	3.45	1.16	1.9	1.6	1.66	1.91
5.....	755.8	2.3	3.33	5.6	-.66	3.6	.83	2.0	1.0	.....	2.41
6.....	737.5	4.12	5.35	3.62	2.87	2.75	2.12	1.87	2.5	.75	1.75
6.....	780.0	6.5	2.14	4.17	1.32	3.17	1.82	2.82	3.17	1.17	2.16
7.....	718.7	4.75	1.78	2.5	1.32	3.22	1.52	3.0	1.75	1.25	2.31
8.....	782.5	5.0	4.28	2.87	.37	4.87	1.5	1.87	2.75	1.62	2.06
9.....	725.6	4.42	3.21	4.16	1.37	2.98	2.2	2.43	1.75	.36	1.71
10.....	727.5	4.87	5.17	3.0	1.12	5.0	1.37	2.62	2.25	.....	1.81
11.....	868.3	8.5	3.33	5.66	.16	3.0	.5	2.66	2.33	.....	1.58
Average for 8 pens.....	.....	5.05	3.57	3.95	.98	3.57	1.48	2.41	2.18	.28	1.97
12.....	671	5.43	5.6	3.8	2.65	5.35	1.75	3.6	.95	3.05	.....
13.....	662.8	1.72	2.61	4.9	3.23	3.65	2.39	3.33	.73	5.18	.....
Average for 2 pens.....	.....	3.57	4.10	4.35	2.94	4.5	2.07	3.46	.84	.....	.....
14.....	636.6	2.28	1.83	.66	5.66	6.0	3.0	3.83	1.03	4.5	.....

* Feed changed on tenth 10 days for pens 1 to 11, inclusive; on ninth 10 days for pens 12, 13, and 14—last three pens fed 79 days.

Referring to the two leading questions submitted to the feed-stuffs and cattle, we will consider, first,

WHAT IS BEST TO FEED WITH COTTON HULLS ?

Summary 1, Table 20, shows that in 90 days feeding—

	Made Av. Gain, lbs.	Cost of Food per lb. Gain.
Pen 7, fed cotton hulls and cotton meal.....	206.2	3.72 cts.
Pen 8, fed hulls, corn, and cob meal..... and cotton meal.....	206.2	4.09
Pen 9, fed hulls, cotton meal and hay.....	215	4.13
Pen 6, fed hulls, cotton meal, and silage.....	233.3	3.71
Pen 10, fed hulls, cotton meal, and molasses.....	238.7	3.73
Pen 11, fed hulls, cotton meal, and molasses.....	251.3	4.1

In 1889, feeding 83 days:

Pen 6, 6 steers, fed cotton hulls and cotton meal.....	202	3.63 cts.
Pen 7, 6 steers, fed cotton hulls, cotton meal, and silage.....	178	3.93
Pen 5, fed cotton hulls, cotton meal, corn and cob meal, and silage.....	197	5.

The latter does not agree with the experiment of the present year, but we consider the results of the last test of more value than those of the first, for the reason that the steers in the several pens were of more uniform quality than in the first experiment, having all come from the same pasture, while the others were a mixed lot picked up over the country, and therefore liable to greater individual variation.

The experiments indicate that cotton meal is the best and cheapest concentrated food to use with hulls, but that the cotton hull and meal ration may be supplemented with something else and improved.

In the experiment just finished hay, silage, and molasses added to the cotton hulls and meal increased the gain made, but corn and cob meal made no difference except to increase the cost. An inspection of Summary 2, Table 2, will show, however, that in this experiment corn does improve the cotton meal and hull ration.

Comparing the gains made by pens 7 and 8 from the beginning to the end of each 10 days, it will be seen that the steers of pen 8 after the first 20 days were from 20 to 30 pounds ahead in gain of the steers in pen 7 until the 80th day, when pen 8 had gained 222 pounds and pen 7 had gained but 183 pounds. For some reason pen 8 lost in weight the last 10 days, shrinking to 206 pounds, while pen 7 kept on increasing and reached the same weight. The gains made by the pens after changing the ration are nearly alike, pen 7 having a slight advantage.

The experiment seems to indicate that all the materials added to the cotton meal and hull ration improved it, but when the value of increased gain, of the ration, and cost is taken into consideration, molasses and silage give the best results.

It is well known that sugar is a fat producer, and that domestic animals easily learn to relish sweets. That a little sweetening makes food more palatable to stock is by no means new, but we believe the use of cheap molasses for this purpose has not been practiced to any extent in this country. We are informed by the proprietor of one of the largest sugar houses in the State that a cheap grade of molasses suitable for feeding purposes may be procured at the sugar houses at from 12 to 14 cents per gallons, f. o. b., if forwarded in tanks or return packages. At this rate molasses could be laid down at feeding plants at the oil mills at 16 cents or less per gallon, and half a pint per day would add only 1 cent to the cost of the day's rations, exclusive of the additional quantity of food that the animal would consume. We would suggest a trial of molasses to men feeding cotton hulls and meal at the oil mills.

WHAT TO FEED WITH SILAGE.

Summary 2, Table 21, shows in 90 days feeding without change of ration:

	Made Av. Gain, lbs.	Cost of Food per lb. Gain.
Pen 3, fed silage and boiled cotton seed.....	164.1	2.8 cts.
Pen 5, fed silage and cotton meal	228.7	3.83
Pen 6, fed silage, cotton meal, and cotton hulls.....	233.3	3.71
Pen 1, fed corn fodder 50 days, then silage 40 days, with boiled cotton seed.	161.6	2.55
Pen 2, silage, corn and cob meal at first, which was gradually replaced by cotton meal	163.7	4.6
In the second lot of steers—		
Pen 12, silage, cotton hulls, and cotton meal....	279	2.72
Pen 13, silage, hay, corn in ear, and raw cotton seed.....	222	3.1

The value of corn fodder, compared with silage, and corn to feed with silage, has been referred to. Page 19.

In 1889, as reported in Bulletin No. 6, feeding 83 days :

	Made Av. Gain, lbs.	Cost of Food per lb. Gain.
Pen 4, fed silage, raw cotton seed, and hay.....	148	2.86 cts.
Pen 3, fed silage, boiled cotton seed, and hay.....	173	2.85
Pen 2, fed silage, cotton meal, and hay.....	170	4.47
Pen 5, fed silage, cotton meal, and hay.....	197	5

The experiments show a decided advantage of cotton meal over cotton seed to combine with silage, so far as increase in gain is concerned. The cost per pound gain, however, is the lowest with the cotton seed.

Comparing pens 12 and 13, the former made the larger gain, which we are inclined to believe would not have been the case if cooked instead of raw seed had been fed to pen 13.

In the experiment of 1889 it will be seen that cooked cotton seed with silage made 25 pounds more gain per head in pen 3 than raw seed with silage made in pen 4, but the cost of food per pound gain was the same. Pen 2, with cotton meal instead of cotton seed, made 3 pounds less gain than pen 3, but at a cost of food per pound gain of 4.47 cents, while the seed made the gain at a cost for food of 2.85 cents.

Pen 2 included an inferior steer, which may account for cotton meal in this pen making less gain than cotton seed, which is contrary to the results obtained in other pens in the experiments of both years.

The steer referred to gained but 60 pounds in 83 days, the next lowest gain being 135 pounds, and the average gain of the other five steers in the pen 192 pounds.

The experiments of the two years seem to show quite conclusively that cotton seed meal excels cotton seed to feed with silage, but while the gain for the time is greater, the cost of food per pound gain is also greater.

COTTON SEED V. COTTON MEAL

As feed stuffs in the early part of feeding.

It having been shown that a change in the ration led to increased gains in all the pens, after feeding more than two months, regardless of the ration the cattle had received, it becomes a matter of interest to know if cotton seed, costing less than cotton meal, will answer the same purpose for the first half or more of the time the cattle are fed.

It should be remembered that as cattle gain in fat the gain per day decreases, and the amount of food consumed for one pound gain increases, other things being equal. Therefore, at the end of 90 days feeding the steers which had made the largest gains should not be expected to take on weight with a different ration as rapidly as cattle that made lower gains.

Pens 1 and 3 fed silage and cotton seed:	Pounds.
Total average gain for 90 days.....	162.6
Gain per day for 90 days.....	1.85
Gain per day from 90th to 110th day, ration changed.....	2.3
Total average gain for 110 days.....	211.6

Pens 2, 4, 5 and 6 fed silage and cotton meal:	
Total average gain for 90 days.....	206.4
Gain per day for 90 days.....	2.29
Gain per day from 90th to 110th day, ration changed.....	1.8
Total average gain for 110 days.....	246.6

Pen 7, fed cotton hulls and cotton meal:	Pounds.
Average gain for 90 days	206.2
Gain per day for 90 days.....	2.29
Gain per day from 90th to 110th day.....	2.1
Total average gain for 110 days.....	252.51

Pens 6, 8, 9, 10, and 11 fed, cotton hulls, cotton meal and corn meal, silage, hay and molasses:	
Total average gain for 90 days.....	230.
Gain per day for 90 days.....	2.51
Gain per day from 90th to 110th day, ration changed.....	1.82
Total average gain for 110 days.....	266.3

The silage and cotton seed fed cattle make the lowest total gain, 211.6 pounds; lowest for the first period and highest for the last.

Silage and cotton meal and cotton hulls and cotton meal make 246.6 and 252.5 pounds; total gain respectively the same gain per day for first period, but hulls and meal fed cattle do better on the changed ration.

The pens fed cotton hulls and cotton meal, with some other food, make the largest total gain, 266.3 pounds; the largest gain per day for first period, but same gain as silage and cotton meal fed cattle on the changed ration.

The cotton hull and meal ration, with some additional food, gives the best results as a single ration, or to prepare the animal for finishing on some other ration, but the lower cost of the cotton seed and silage rations places the farmer who desires to feed cattle on a par with the oil mill men.

HAY AND CORN.

It is not the aim of this investigation to discourage the use of corn and hay for fattening cattle.

Texas has a large area of land specially adapted to corn growing, and on which corn is the most certain and reliable crop the farmer can grow. At present a great deal of this corn will not sell for more than 20 cents per bushel, after paying cost of moving to the station and railway charges for transportation to market.

This corn should be converted into beef and pork, and with the present and prospective prices for cattle and hogs, corn may be made to bring more than 20 cents a bushel, if fed under the best conditions.

In the experiment of 1889, estimating corn at 40 cents per bushel and hay at \$6 per ton, six steers made average gain of 173 pounds, at cost of 4.16 cents, and five steers made average gain of 158 pounds, at cost of 6.83 cents per pound gain for food consumed; the former fed under shelter, the latter in open lot.

The result obtained with pen 14 the present year in adding boiled cotton seed to corn and hay indicates that we could have lowered the cost for food from 25 per cent to 30 per cent, by adding boiled cotton seed to the hay and corn rations referred to.

Pen 8, 1889, fed under shed, consumed per head in 83 days, 16.17 bushels corn and 256 pounds hay, and gained 173 pounds.

Pen 9, fed in open yard, consumed per head in 83 days, 18.01 bushels corn and 1200 pounds hay, and gained 158 pounds.

Pen 11, 1890, fed in open yard, consumed per head in 79 days, 15.13 bushels corn, 591.5 pounds hay, 342.5 pounds cotton seed, and gained 233.3 pounds.

Year.	Average Daily Ration.	Food per Pound gain.	Value Food per pound gain.	Gain per day per head.
1889—Pen 8..	3.08 lbs. hay. 10.91 lbs. corn.	1.47 lbs. hay. 5.22 lbs. corn.	44 cts.	2.09 pounds.
			3.73 cts.	
			4.17 cts.	
1889—Pen 9..	14.1 lbs. hay. 12.15 lbs. corn.	7.4 lbs. hay. 6.38 lbs. corn.	2.26 cts.	1.9 pounds.
			4.54 cts.	
			6.80 cts.	
1890—Pen 14.	7.49 lbs. hay. 10.72 lbs. corn. 4.46 lbs. cotton seed.	2.57 lbs. hay. 3.63 lbs. corn. 1.46 lbs. cotton seed.	.75 cts.	2.95 pounds.
			2.59 cts.	
			.52 cts.	
			3.86 cts.	

There was considerable hay wasted in pen 9, although the feeding was carefully done. The steers in pen 14 were better eaters than the steers in pens 8 and 9, but the more rapid gain is largely due to adding boiled cotton seed to the corn and hay ration. The fact that in feeding this pen of steers corn and hay for thirty days they made the least daily gain in weight of any of the pens, and that after adding cotton seed they gained as rapidly as any of the pens (see page 21), supports this view.

The cost of food per pound gain with corn, hay and cotton seed is below that of several pens on cotton hulls and cotton meal, and if we estimate the value of corn, hay, and cotton seed at average farm prices in the corn belt, it will reduce the cost per pound gain nearly to that of the cheapest foods, and to a figure that can not be reached in the Northern States.

HOGS WITH COTTON SEED FED CATTLE.

Pigs were put in with the cattle in pens 12 and 13, one pig to each steer, and the increase in weight determined from January 26 to March 16, fifty days.

Very little food was scattered on the ground in feeding the cattle (the managers were constructed so that the steers could not throw it out), and the pigs were practically confined to the droppings of the cattle and corn fed to them direct.

It was thought best to feed each lot of pigs sufficient corn to keep them quiet and in good growing condition, but not enough to keep them from getting hungry.

In pen 12, cattle fed silage, cotton hulls, and cotton meal:		Pounds.
January 26, average weight of pigs		57
March 16, average weight of pigs		87.5
Average gain per head		30.5
Pounds corn per head		132
Pounds corn fed per pound gain		4.39

Pen 13, cattle fed silage, hay, corn in ear, and raw cotton seed:		
January 26, average weight of pigs		52
March 16, average weight of pigs		86
Average gain per head		34
Pounds corn fed per head		108.3
Pounds corn fed per pound gain		3.18

In pen 12 one bushel corn, in addition to cattle waste, made 12.75 pounds gain.

In pen 13 one bushel corn, in addition to cattle waste, made 17.61 pounds gain.

The waste from silage, hay, corn, and cotton seed fed steers gave approximately 36 per cent more increase in weight than the waste from silage, cotton meal, and hull fed steers.

The low increase in weight made as compared with the usual gains made by hogs running after fattening cattle may be accounted for perhaps by the crowded condition of the pens, and the fact that practically none of the food given to the cattle was thrown on the ground where the pigs could get it.

In the usual manner of feeding corn and hay in racks in open lots, a considerable quantity of the corn is dropped on the ground in filling the troughs, and the cattle throw out a good deal, so that pigs are by no means confined to the undigested corn voided by the cattle.

There is no question but that in feeding dehorned cattle under shelter with properly arranged troughs, even with whole corn and hay, that the value of the waste for hog food will be decreased 30 to 50 per cent compared with the ordinary method of feeding, and that when whole corn is replaced partly or wholly by corn meal, cotton seed, and cotton meal, that the value of the waste will again be reduced to a considerable extent.

The cattle and pigs were in too close quarters for the best welfare of the pigs, and this single test, no doubt, does not fairly represent the full value of the waste from the two rations fed to cattle. The two lots of pigs had an equal chance, and it may therefore represent the comparative value of the two rations.

SILAGE AND COTTON HULLS FOR SHEEP.

Two lots of common native sheep, nine in each, were put in pens, and one fed on silage and raw cotton seed, the other on cotton hulls and cotton meal. The sheep were fed all they would eat for 64 days.

Pen 1, 9 sheep, fed silage and cotton seed:	Pounds.
Average weight January 1.....	62
March 6, average gain per head.....	12.4
Average gain per head per day.....	.193
Silage consumed per head per day.....	2.62
Cotton seed consumed per head per day.....	.814

Food consumed per head:	
169.75 pounds silage at \$2 per ton.....	17 cts.
52.17 pounds cotton seed at \$7 per ton.....	18

Cost of food for 64 days.....	35
Cost of food per pound gain (cents).....	2.82

Pen 2, 9 sheep, fed cotton hulls and cotton meal:	Pounds.
Average weight January 1.....	61.5
March 6, average gain per head.....	17.8
Average gain per head per day.....	.278
Cotton hulls consumed per head per day.....	.97
Cotton meal consumed per head per day.....	.97

Food consumed per head:	
62.2 pounds cotton hulls at \$3 per ton.....	9.2 cts.
62.2 pounds cotton meal at \$8 per ton.....	62.2

Cost of food for 64 days.....	71.4
Cost of food per pound gain.....	4 cts.

The foregoing test was made preliminary to feeding several pens of sheep to compare the effect of different rations on sheep, and returns made by cattle and sheep for food consumed.

The sheep seemed to take their food regularly, but they did not eat enough, and did not gain in weight as they should.

It required 13.75 pounds silage and 4.20 pounds cotton seed to produce 1 pound gain in weight, and 3.49 pounds cotton hulls and 3.49 pounds cotton meal to produce 1 pound gain in weight.

Sheep have been successfully fattened on cotton hulls and cotton meal, and we must therefore charge our lack of success to poor quality of the sheep, or to unskillful feeding.

CONCLUSIONS.

1. The experiments for the two winters show that of our different cattle foods, a ration made up of cotton hulls and cotton meal is equal, if not superior, to a ration of any other two feed-stuffs used for fattening cattle, but a cheaper ration may be compounded of silage and cotton seed, or of corn, hay, and cotton seed, at the prices given.

2. That the addition of some other feed-stuff to the cotton hull and cotton meal ration makes it more palatable to cattle, and produces better results in gain in weight. Corn meal, hay, silage, and molasses, each one added to cotton hulls and cotton meal, made larger gains than hulls and meal alone, in the order named, molasses giving the best result.

3. Of the several rations containing silage, silage, cotton hulls, and cotton meal gave the best gains. Silage and cotton meal second. Silage and boiled cotton seed third. Silage, corn and cob meal, and cotton meal fourth. Silage, corn and cob meal fifth. Dry corn fodder did not give as large gain as silage. Molasses did not improve the ration containing silage.

4. Cotton hulls and cotton meal with hay, corn, silage, and molasses gave larger gains than silage and cotton meal, or silage and cotton seed.

5. Cotton seed meal, with other feed-stuffs and fodders, gave larger gains than cotton seed with other feed-stuffs and fodders.

6. Cotton seed, with other feed-stuffs and fodders, made gains at less cost for food per pound gain than cotton meal with other feed-stuffs and fodders.

7. After feeding any of the rations used without change for 60 days, the daily gain diminished until finally, in some pens, it ceased entirely; but with a change of ration, the daily gain in all of the pens was largely increased, in some pens exceeding the average of the first period of feeding.

8. Corn and hay alone is more costly, and will not fatten cattle so rapidly as rations containing cotton seed and cotton meal, with cotton hulls or silage; and boiled cotton seed added to the corn and hay ration makes more rapid gain than corn and hay alone, and at considerable less cost per pound for food consumed.

9. The waste from cattle fed hay, corn, silage, and raw cotton seed was worth considerable more for hogs running after the steers than the waste from cattle fed silage, cotton hulls, and cotton seed meal.

FEEDING CATTLE IN OTHER STATES.

A copy of the following letter was sent to several cattlemen and persons interested in stock, in Texas and in other States:

DEAR SIR—I want to get estimates of the cost of fattening cattle in different sections of the country. I shall be under obligations if you will give me the benefit of your experience and observations in replying to the following questions, referring to your State:

1. What feed-stuffs are used by your cattle feeders?
2. Average value past winter; average value past five years.

3. What is the daily ration; how long are cattle fed, and what is the gain made and cost of same?

4. Is it believed by cattlemen that it pays to shelter cattle while feeding?

Many replied that they could not give the desired information, as weights of cattle and quantity of food consumed were so seldom kept; and others stated they would reply as soon as data could be secured.

We extract from several of the replies received:

From R. L. Maupin, Mobile, Alabama:

Fed 700 head this winter; sold 500 to date; 40 steers cost $2\frac{1}{2}$ cents gross, remainder 2 cents; 500 sold averaged 650 pounds weight when put up and 850 pounds when sold, and averaged 100 days feeding.

Average daily ration:	Cents.
18 pounds cotton hulls, worth.....	3.5
5 pounds cotton meal, worth.....	5
4 pounds cracked corn, worth.....	3
Cost of labor.....	0.5

Cost per day per head (cents) 12

Which would make the average gain in weight cost 6 cents per pound.

Sold 100 head early at 3 cents; a little later 100 more at $3\frac{1}{2}$ cents, and still later 300 head at $3\frac{1}{2}$ cents; expect to do better on the remaining 200 head.

From Mr. Maupin's figures we have for the 500 sold:

To 460 steers, 299,000 pounds, at 2 cents per pound.....	\$5,980
To 40 steers, 26,000 pounds, at $2\frac{1}{2}$ cents per pound.....	635
To 100 days food and care 500 head, at 12 cents.....	6,000
	<hr/>
	\$12,613
By 100 beeves, 85,000 pounds, at 3 cents.....	\$ 2,550
By 100 beeves, 85,000 pounds, at $3\frac{1}{2}$ cents.....	2,975
By 300 beeves.....	8,925
	<hr/>
	\$14,450

Not allowing for losses, profit of \$1837.

Mr. Maupin writes that he dehorned 200 head, but the winter was so warm that the worms gave him a great deal of trouble—so much so that he lost a good deal of time and food with the dehorned steers, and four of the steers died. In replying to a second letter, Mr. Maupin states that the bad effects were due to the worms, and not to the dehorning direct.

From C. L. Ingersol, Director of the Colorado Experiment Station, Fort Collins, Colorado:

Most feeders use alfalfa alone and feed in racks. They build sheds open to east and south, give fresh water, and allow the steers to run loose all the time. If a few seem weaker than the rest they are separated in a smaller corral and given a little better chance. Rubbing posts are erected, and salt boxes fastened between stakes, and lumps of rock salt placed in them. I will get some data from a feeding farm just west of here, where alfalfa alone is being and has been fed for five years. They make the hay net them about \$6 per ton, however, year by year, after paying all expense. They buy steers or bring their own in off the range for this purpose. Hope to get the data within a week for you.

You will understand, however, that nearly all Colorado beef is cut out at the round-ups in June and November, and shipped to Chicago and Kansas City.

It is well attested that shelter is valuable, and no corral is built without some shed shelter, often made of poles, brush, and earth only.

From W. A. Henry, Director of the Wisconsin Experiment Station:

Your questions about steer feeding are very difficult to answer, because there is no carefully collected data at hand. Our best feeders usually rely on "shock corn," i. e., corn which has been cut and shocked in the field, and from which the ears have not been husked. This shock corn is drawn directly from the field as needed, and thrown into large feeding boxes.

The cattle are supplied in great abundance, the corn being in front of them most of the time. A great deal of the corn passes unmasticated, and is picked up from the droppings by hogs, which gain rapidly therefrom. You can easily see that figures are difficult to obtain, under the circumstances. An average of two feeding trials by us gives the following: To make 100 pounds of gain, steers ate 677 pounds of grain, which was one-third bran and two-thirds shelled corn, together with 518 pounds of hay. Hogs following these steers required 154 pounds of corn for 100 pounds of gain, showing that the hogs got the equivalent of 350 pounds of corn from the droppings of the steers. Our feeders doubtless get from 6 to 10 pounds of gain from a bushel of corn and the fodder which goes with it, while the hogs probably gain about 3 pounds for the same. Shelled corn was worth about 30 cents this year; 35 to 40 past years. The daily ration is all the cattle will eat, which amounts to enough to put on a gain of about 2½ pounds a day. Our cattlemen do not believe in tying up cattle in warm barns, but rather in having an open shed, under which they can run to get out of the storms, with a part of the yard left uncovered. The system is to feed heavily, with hogs following. It seems very crude, but after all it is the proper way, judging from the results. Many feeders get all their profits from what the hogs gain; indeed, without the hog adjunct, I think steer feeding would be almost entirely given up at the West, with present prices for cattle.

The above is not very satisfactory, but the best I can do.

From Samuel Johnson, recently President of Michigan Shorthorn Breeders' Association, and Professor of Agriculture, Michigan Agricultural College, Lansing, Michigan:

1. Corn and oats ground in equal parts is the principal grain fed in Michigan. A good deal of wheat bran and some oil meal and other grains are used to some extent, but the main dependence is the corn and oats. Straw, corn fodder, and hay are the rough fodders used.

2. Oats, 25 cents per bushel; corn, 40 cents per bushels; wheat bran, \$11 per ton; hay, \$8. The average for five years would not be materially changed from those figures, except corn, which has ranged higher.

3. The daily ration depends on age and weight of cattle fed, of course. I mail you two of my college bulletins that will help to answer this inquiry.

4. The majority of our cattlemen and all of our best feeders believe in shelter. Cattle can not be profitably fed in Michigan without protecting in the winter season.

From George E. Morrow, Professor of Agriculture, Champaign, Illinois:

Most of the beef cattle in Illinois are fattened on Indian corn as the sole grain ration, with grass in summer; grass or clover hay, corn fodder, and perhaps some straw in winter.

For the whole State the corn was worth last winter from 20 to 25 cents per bushel on the farms; the hay about \$5 per ton. For the past five years the average value of the corn may be placed at 28 to 30 cents per bushels, ½ cent per pound for shelled corn; with the hay at \$5 to \$6 per ton, ¼ cent per pound.

It is difficult to give the average daily ration. In the majority of cases the feeders give the cattle practically all they will eat of corn, feeding the ears, or more rarely the shelled corn in boxes, in fields or yards; or feeding stalks and ears together, either in racks or on the ground. From one-fourth to one-third of a bushel per day roughly approximates the ration per day of corn.

There is great variation in practice as to length of time cattle are fed. Many commence grain feeding in early fall, with new corn fed to the cattle still on pasture, continuing this until winter is fairly established—three months or more. Others, and in large numbers, commence full feeding in late winter or early spring, continuing until cattle are well fattened after being turned on the grass. Still others full feed for a year or more. Usually the largest gains in proportion to the grain fed are made by the cattle under the first described system; under favorable circumstances as much as 90 pounds per month each for three months. It is difficult to make a satisfactory estimate of the cost of this gain. Feeders expect a profit, in part, from the increased value of the whole carcass, and also from the pork made by the pigs, which almost always have access to the droppings of the cattle. My belief is that with good cattle and good management, good beef cattle can be sold at the farms in Central Illinois at 4 cents per pound live weight, and give a small profit.

The older class of feeders rarely put a belief in the value of shelter for fattening cattle into practice. The percentage which have sheds while being fattened is increasing somewhat rapidly. In Northern Illinois sheds or stables are the rule.

It will be understood that thousands of cattle are fattened in the State under very different management from any indicated above. In connection with the large distilleries many cattle are fed. In the aggregate many cattle are fed in stables, with ground grain, oil cake, etc., but these make but a small percentage of the whole number annually fattened.

From R. P. Speer, Director of Iowa Experiment Station:

In answer to your letter, I will say that I have not had as much experience in feeding cattle as many other Iowa stockmen. I have given most attention to the feeding of dairy cows; but I can answer most of your questions. Corn has been worth from 16 to 20 cents per bushel in Iowa during the past winter. Average value during the past five years, about 25 cents per bushel.

Corn is the feed used in fattening cattle and hogs. There is no daily ration. Generally the cattle are allowed all the corn that they will eat. But little attention is given to daily gain. When the market is favorable the cattle are shipped that are in shipping condition, and the poorer ones are allowed to run longer on the feed. Corn is generally fed in the ears. For fully grown cattle, the only shelter required is a good grove.

If feed was more costly it would pay better to give better protection.

What I have said applies to the large feeders. The small feeders do give shelter to their steers, but generally the small feeders have made no money during the last ten years.

It don't pay to feed less than a car load, and then the owners should ship their own steers.

From William Saunders, Director Central Experimental Station, Ottawa, Canada:

Yours of the 27th received. I am not very familiar with the subject of cattle feeding generally, my work confining me very close to the Experimental Farm here; but I understand our cattle feeders are getting to use ensilage very generally, and supplementing it with hay, bran, ground oats, peas, and roots. I can not say what the average value of fodder has been in Canada, as the price varies so much in different sections of country. Hay in this vicinity has been worth \$11 per ton, but in some parts of Canada it is worth more, and in other sections only \$7 or \$8. Roots are estimated to be worth about \$4 per ton. Bran costs about \$12 per ton here, and ensilage costs us on the Experimental Farm \$1.80 per ton in the silo. I can not say what the average has been during the past five years. The daily ration fed to our cattle here (we have only had them in stock a few months) is 25 pounds ensilage, 20 pounds of roots, 4 pounds of bran, and 2 pounds of ground oats, with $\frac{1}{2}$ peas, and 10 pounds of straw; this is the ration for a cow weighing 1000 pounds; for heavier cattle there is an increase in proportion. Under this ration some of our cattle have gained as much as three pounds per day, others gained a pound or a pound and a half; much depends on the breed of the animal and the constitution of the individual. Our best cattlemen here stall feed their cattle, and give them good warm stables in the winter.

TEXAS AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 11,

AUGUST, 1890.

EFFECT OF COTTON SEED AND COTTON SEED MEAL
ON BUTTER PRODUCT.

QUALITY OF SWEET CREAM BUTTER

AS COMPARED WITH

BUTTER MADE FROM ACID CREAM.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

All Bulletins of this Station are issued free. Any one interested in any branch of agriculture may have his name placed on our permanent mailing list, and secure future numbers, by application to

GEO. W. CURTIS, DIRECTOR,
College Station, Brazos Co., Texas

In requesting Bulletins, write name and address plainly.



AUSTIN:
STATE PRINTING OFFICE
1890

TEXAS AGRICULTURAL EXPERIMENT STATION.

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P. S. TILSONAssistant in Chemistry.

LETTER OF TRANSMITTAL

To His Excellency L. S. Ross, Governor of Texas:

SIR—I have the honor to transmit to you the Third Annual Report of the Texas Agricultural Experiment Station.

Very respectfully,

A. J. ROSE,
President Board of Directors A. and M. College of Texas.

TEXAS AGRICULTURAL EXPERIMENT STATION.

REPORT OF DIRECTOR AND AGRICULTURIST.

COLLEGE STATION, TEXAS, January 1, 1891.

To the Hon. Board of Directors of the Agricultural and Mechanical College of Texas, Major A. J. Rose, President:

SIR—In accordance with the law relative thereto, I have the honor to submit herewith, for transmission to his Excellency the Governor of the State of Texas, the Third Annual Report of the Texas Agricultural Experiment Station for the calendar year 1890, with financial statement to the close of fiscal year June 30, 1890.

The work accomplished during the year has, I am glad to say, met with marked approval from readers of our Bulletins, and our mailing list has rapidly increased. Of Bulletins Nos. 11, 12, and 13, 5000 copies each were issued; and we shall doubtless be compelled to issue an extra thousand very soon to meet the increased demand.

The several departments of the Station are fairly well equipped, well officered, and on a good working basis. We have every reason to believe that the Station will grow in usefulness with each succeeding year.

Our investigations during the year just passed, briefly enumerated, cover: Dairy work, including the effect of the different foods, especially cotton seed and cotton seed meal, on yield and quality of butter, temperature and conditions for churning as dependent on different foods, quality of sweet cream butter as compared with butter made from acid cream, and methods of creaming milk; cattle and hog feeding, especially with reference to the best possible use of cotton seed and cotton seed meal and hulls for profit, and the best methods of growing, handling, and feeding ensilage and soiling crops; variety tests with field, orchard, and garden varieties; investigation of cotton blight or root-rot disease; determination of the digestibility of Southern food products; analyses of food stuffs, fertilizers, and dairy products; tile drainage; diseases of live stock—methods of curing and prevention, especially the so-called Southern cattle fever, which this Station has been carrying on in connection with the Missouri Experiment Station; boll and leaf worm pests of cotton; weevil in corn, and other matters of less immediate importance.

The reports from the members of the Station staff submitted herewith will explain more in detail the nature of work in progress. Results already attained are published in Station Bulletins issued during the year, Nos. 9 to 13 inclusive, which see.

On taking active charge as Director, July 1, 1890, I found it necessary to inaugurate a permanent system looking to the better preservation, filing, and indexing of valuable correspondence and experimental data awaiting publication, while at the same time so paging and arranging Station publications as to make an index of successive Bulletins, with Annual Report for each year, possible, and leave it all in convenient shape for binding in volumes by years, if the recipient should so desire. In furtherance of this plan an index to all Bulletins issued during the year is attached and made a part of this Report, which is issued in size and style uniform with all Bulletins of the Station.

Our Station mailing list has been carefully revised and corrected, and we

are now arranging this list alphabetically by counties, and will have printed for permanent use.

Our files of Bulletins from other States were found very incomplete, and active efforts were made to secure missing numbers. Some of these it will be impossible to obtain on account of editions being exhausted; but nearly all have been secured in duplicate, making it possible to furnish an almost complete set of back numbers for the College library, where reference may be had at any time by students interested in agricultural research, without using the files in Station office.

BRANCH STATIONS.

Experiments have been undertaken at each of the following points, lines of work being as noted for each: At Harlem, Fort Bend County, for sugar investigation; at Gatesville, Coryell County, for grass tests; at McGregor, McLennan County, wheat and other tests; at Rusk, Cherokee County, Huntsville, Walker County, and Prairie View, Waller County, for horticultural investigation.

In this manner we are able to cover quite largely the different climatic and soil conditions of the State, and it is our intention to extend the work as fast as funds will permit. So far as we have gone in this matter it has been at comparatively slight expense, for the reason that all of the land and nearly all of the labor has been furnished *gratis*.

In my opinion a branch station should be established in some part of the great Black Waxy belt of North Texas, and another in either the Wichita or Abilene country wheat belt, for investigation of problems which immediately concern the inhabitants of the sections named. To do this, however, will require funds in excess of the government appropriation under the Hatch Act to the Texas Agricultural Experiment Station, and I would suggest that, if the plan meet with your approval, an appropriation of \$5000 annually be asked from the State Legislature soon to convene, for the purpose of equipping and continuing in operation branch stations as noted.

Respectfully submitted,

GEO. W. CURTIS,

Professor of Agriculture and Director of Experiment Station.

REPORT OF CHEMIST.

COLLEGE STATION, TEXAS, January 1, 1891.

Prof. Geo. W. Curtis, Director:

DEAR SIR—Herewith I present statement of work done in Chemical Department during 1890: Bulletin No. 13, just published, including a study of sorghum as forage, as silage, exhaustion of soil, digestibility; analyses of teosinte at different stages of growth; analyses of forage corn, Indian corn; miscellaneous analyses; analyses of silage samples. We have also analyzed a sample of Sotja beans, eight samples of corn and corn fodder, and one hundred and fifty samples of milk for butter content, by your request.

By request of the Professor of Horticulture we have analyzed samples of native grasses and of fertilizers, the results to be published later.

Other lines of investigation have been in progress that will afford results for publication at some future time.

Yours, etc.,

H. H. HARRINGTON,
Chemist.

REPORT OF VETERINARIAN.

COLLEGE STATION, TEXAS, January 1, 1891.

Prof. Geo. W. Curtis, Director:

SIR—The following is the report of the Veterinarian for 1890: The work during the past year has been as follows:

1. The experiments with Texas cattle fever have been carried out in accordance with the agreement with the Missouri Station. I regard it as unfortunate to have any experimental material owned or controlled by private parties.

2. The results of the investigation of the screw worm have been made public through Bulletin No. 12. This subject should be followed until we have accurate data on the life history of this pest.

3. Considerable effort has been made to determine the specific character of the Spanish itch of horses, and remedies. The data so far is too meager for publication.

The attention of the Station authorities is here called to the unsuitableness of the present laboratory for experimental purposes, especially with reference to pathogenic organisms

I would recommend that the following work be provided for during the coming year:

1. An investigation of the extent of the "liver fluke" in cattle and sheep in the State.

2. The more careful study of big jaw in cattle and its mode of transmission.

3. The study of effects of spaying heifers. This can be accomplished by the Station furnishing a veterinarian to do the spaying for private parties, and thus secure average results.

4. The study of the reported bad effects of spoiled cotton meal on cattle and hogs.

The lines of work indicated can be carried out with comparatively small cost.

Respectfully submitted,

M. FRANCIS,
Veterinarian.

REPORT OF HORTICULTURIST.

COLLEGE STATION, TEXAS, January 1, 1891.

Prof. Geo. W. Curtis, Director:

SIR—In accordance with your request, the following report of the work in horticulture at this Station is submitted:

Since the last Annual Report of the Experiment Station the Station has published Bulletin No. 9, edited by Prof. Brunk and his assistant, H. S. Jennings. The Bulletin discussed the comparative merits of different pear stocks, and contained a list of ninety-five Texas fungi, with notes on their economic importance.

APPLES.

Of the sixty-three varieties of apples reported as growing in the Experiment orchard a year ago several have died. These have been replaced with the same varieties so far as practicable, so that the list as last reported is practically unchanged. Since none of the orchards of the Experiment Station have been set more than two years, definite results can not be reported yet. Progress will be reported each season.

It has been thought advisable to admit to the Station orchards a few of the best Russian apples. Arrangements have been made for planting about twenty of these.

CRAB APPLES.

Nine varieties of crab apples were reported in Bulletin No. 8, issued a year ago. All these have a healthy appearance and have made a vigorous growth.

PEARS.

With few exceptions the pears listed in Bulletin No. 8 have made satisfactory growth. The list remains nearly the same.

PEACHES.

The Station peach orchard contained one hundred and sixty-one varieties one year ago. Each variety, with few exceptions, was represented by two trees. Duplicates have not been readily obtained of some varieties that failed to grow, and the list then reported has been considerably changed.

PLUMS AND OTHER FRUITS.

The sixty-five varieties of plums reported in Bulletin No. 8 are all growing finely, and the list is unchanged. The same may be said regarding the twelve varieties of APRICOTS and ten varieties of PERSIMMONS.

All figs were injured, and a few kinds were killed by the severe late frost last spring.

GRAPES.

The test vineyards contained a year ago ninety-six varieties of grapes, including specimens of wild forms of nearly all species of *Vitis*. A few young vines failed to grow, but the list remains nearly the same as at the last report. The new vineyard is being extended.

SMALL FRUITS.

The RASPBERRY list remains the same as previously reported. A few additions have been made to the list of BLACKBERRIES and DEWBERRIES. Experiments now in progress with STRAWBERRIES are expected to show the effect of deep drainage and shallow drainage as compared with equal areas undrained; the effect of fertilizers rich in nitrogen, in phosphorus, or in potash, as compared with unfertilized land; also the results of mulching during the dry season as compared with thoroughly clean culture.

TREES AND SHRUBS.

The list of trees and shrubs mentioned in Bulletin No. 8 has been very much changed during the year. Many kinds have done well, others have done poorly, while others have failed entirely. The experiments with trees and shrubs in the arboretum and on the campus will be very valuable in demonstrating which exotic or native species fail in this locality, and which ones prove best adapted to our soil and peculiar climatic conditions.

S. A. BEACH,
Horticulturist.

REPORT OF METEOROLOGIST.

COLLEGE STATION, TEXAS, January 1, 1891.

Prof. Geo. W. Curtis, Director.

SIR—Herewith find, at your request, report for year 1890. The meteorological observations have been taken during a period extending over a little more than two years, and are becoming of value, as the conditions of the weather from year to year can now be compared.

The work consists in recording twice daily, at 8 a. m. and 8 p. m., the atmospheric pressure, air temperature, dew point, relative humidity, maximum and minimum temperatures, direction of the wind, rainfall, and such other atmospheric phenomena as may be of interest or importance.

Below are found general summaries for 1889 and 1890 respectively, given by months, and the average for each year taken from the monthly averages.

Summary for 1889.

	Height of Barometer in inches.	Temperature, Fahr.			Rainfall.	Prevailing Wind.
		Mean.	Maximum.	Minimum.		
January	29.729	48.32	68.00	28.00	7.07	N.
February	29.776	51.46	73.50	24.50	2.29	S.
March	29.636	57.42	84.00	41.00	2.38	S.
April	29.612	68.10	.....	50.00	2.74	S.
May	29.638	71.85	.....	53.00	2.42	S.
June	29.601	78.42	99.00	58.00	9.01	S.
July	29.611	82.45	104.00	71.00	2.47	S.
August	29.640	80.25	102.00	68.00	1.19	S.
September	29.714	72.50	94.00	58.00	14.77	S.
October	29.729	66.70	97.00	43.00	0.11	S.
November	29.705	51.96	85.00	32.00	6.06	N.
December	29.940	63.11	87.00	35.00	0.07	S.
Total	356.331	792.54	893.00	561.50	50.68	
Average	29.694	66.04	89.30	46.79	4.215	S.

Summary for 1890.

	Height of Barometer in inches.	Temperature, Fahr.			Rainfall.	Prevailing Wind.
		Mean.	Maximum.	Minimum.		
January	29.799	57.32	83.50	26.00	6.94	S.
February	29.691	58.78	84.00	20.00	3.28	S.
March	29.697	59.83	90.00	22.00	3.93	S.
April	29.719	65.62	87.00	45.00	5.55	S.
May	29.591	72.51	95.00	55.00	4.33	S.
June	29.676	77.54	97.00	61.00	4.95	S.
July	29.702	78.95	99.00	70.00	0.45	S.
August	29.678	80.30	97.00	68.00	0.75	S.
September	29.675	74.27	98.00	48.00	4.92	S.
October	29.683	66.66	90.00	46.00	2.62	N.
November	29.811	57.35	87.00	37.00	0.99	N.
December	29.853	53.53	89.00	24.00	1.73	S.
Total	356.575	802.68	1096.50	522.00	40.44	
Average	29.714	66.97	91.37	43.50	3.37	S.

The averages for the past two years are almost the same except in the amount of rain, the rainfall for both years being above what is considered the usual fall—about 36 inches.

Eighty-nine was a very wet year, but the fall of rain was pretty evenly distributed.

Ninety had also an excessive amount of rain, but the greater portion fell before the middle of June, and from then on until September a severe drouth was sorely felt.

On the 28th of February, 1890, we were struck by a severe blizzard, the temperature falling as low as 20 degrees above zero, Fahrenheit. Owing to the previous mild weather, of several weeks duration, this cold spell did an immense amount of damage, vegetation being then far advanced and most of the fruit trees in full bloom. The fruit crop at the College was entirely ruined, and many trees on the campus were killed to the ground.

Frost occurred first on the 4th of November, which is quite early for this place.

The College is situated in latitude 30 degrees 40 minutes north and longitude 96 degrees 15 minutes west, and is about 360 feet above sea level.

DUNCAN ADRIANCE,
Meteorologist.

FINANCIAL STATEMENT.

Texas Agricultural Experimenting Station in Account with Treasury Department for Year Ending June 30, 1890.

	Dr.	Cr.
To Cash United States appropriation.....	\$15,000 00	
Cash sundry receipts.....	3,396 01	
Balance.....	186 53	
By balance July, 1889.....		\$530 96
By cash for labor.....		2,567 25
By cash for seeds and plants.....		74 85
By cash for fertilizers.....		44 56
By cash for equipment.....		1,105 10
By cash for office supplies.....		13 50
By cash for expense.....		961 70
By cash for printing.....		220 81
By cash for salaries.....		8,637 50
By cash for forage.....		1,910 69
By cash for live stock.....		1,596 00
By cash for buildings.....		55 21
By cash for student labor.....		21 80
By cash for Horticultural Department.....		262 65
By cash for Veterinary Department.....		101 00
By cash for Agricultural Department.....		34 20
By cash for branch stations.....		59 70
By cash for grass station.....		72 61
By cash for sugar station.....		312 45
	<u>\$18,582 54</u>	<u>\$18,582 54</u>

We the undersigned, Finance Committee of the Board of Directors of the Agricultural and Mechanical College of Texas and Governing Board of the Texas Agricultural Experiment Station, do hereby certify that we have examined the books and accounts of said Station for the fiscal year ending June 30, 1890; that we have found the same correctly kept and classified as re-

quired by law, the receipts and disbursements agreeing with stubs and vouchers on file in the Treasurer's office and found correct in detail.

L. L. FOSTER,
JOHN ADRIANCE,
Finance Committee.

I certify that the foregoing statement is a true copy from the books of the Texas Agricultural Experiment Station.

W. L. BRINGHURST,
Treasurer.

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